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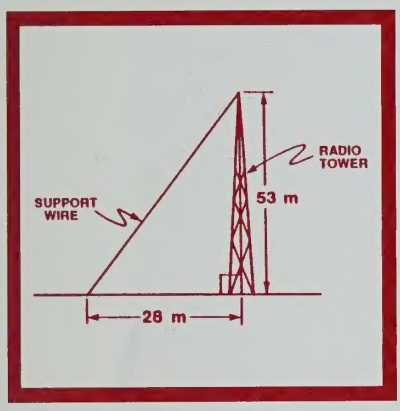
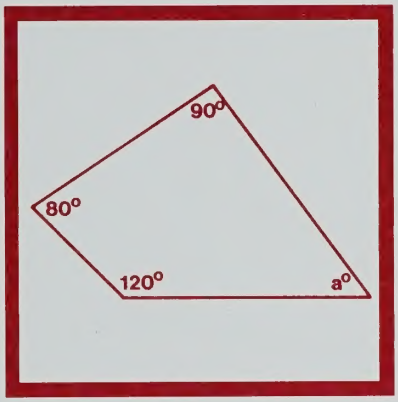
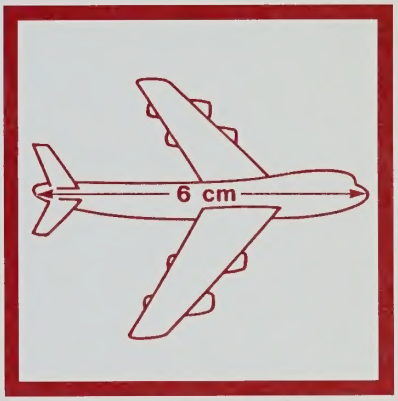
MATHEMATICS

Grade 10
(General Level)

A REPORT FOR EDUCATORS







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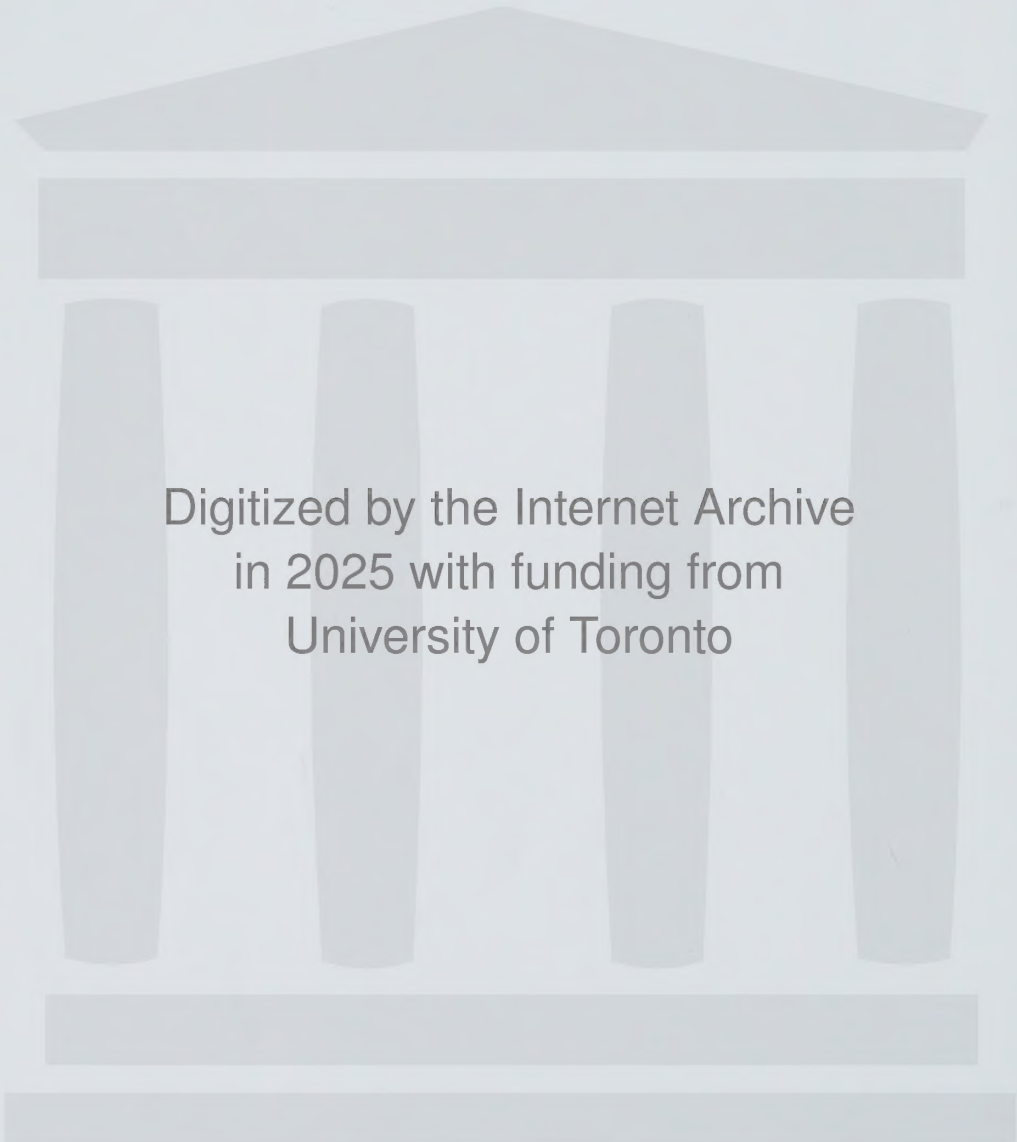
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Mathematics
Grade 10 (General Level)
A Report for Educators

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Table of Contents

Acknowledgements iii

Executive Summary v

1. Purpose of the Review 1

2. Mathematics in Ontario Schools 3

3. Description of the Measures and Samples for the Provincial Review 4
- 3.1 The Instruments 4
- 3.2 Development and Administration of Instruments 9
- 3.3 Interpretation of Results 9
- 3.4 Provincial Review Participants 12
- 3.5 Board Review Participants 13

4. Principal Questionnaire 14
- 4.1 Enrolment 14
- 4.2 The Location of School and Structure of Program 14
- 4.3 Frequency of Staff Meetings on Mathematics 15
- 4.4 Use of Planning Documents 15
- 4.5 Reviews of Mathematics Programs 15
- 4.6 Professional Development 16

5. Teacher Questionnaire 17
- 5.1 Characteristics and Educational Background 17
- 5.2 Importance of Mathematics Topics 18
- 5.3 Problem Solving 19
- 5.4 Homework 19
- 5.5 Use of Calculators and Computers 19
- 5.6 Instructional Materials 20
- 5.7 Teaching Methods 21
- 5.8 Evaluation 21

6. Student Questionnaire 22
6.1 Background Characteristics 22
6.2 Mathematics Activities Outside School 22
6.3 Student Attitudes Towards Topics in Mathematics 24
6.4 What Happens in Mathematics Classes 25
6.5 Use of Calculators and Computers 26
6.6 How Students Feel About Mathematics 26
6.7 Solving Mathematics Problems 29

7. Planning Documents 31
7.1 Type of Document 32
7.2 Rationale/Objectives 32
7.3 Content Areas 32
7.4 Teaching Methods 33
7.5 Calculators and Computers 34
7.6 Evaluation Practices 34
7.7 Conclusion 34

8. Student Achievement 35
8.1 Numerical Methods 38
8.2 Algebra 52
8.3 Geometry 64
8.4 Process Problems 73
8.5 No-Calculator Questions 74
8.6 Opportunity to Learn 76

9. Summary and Conclusions 78
9.1 Student Achievement 78
9.2 Student Attitudes 79
9.3 Classroom Activities and Classroom Practices 79

Appendix A: Principal Questionnaire 81
Appendix B: Teacher Questionnaire 85
Appendix C: Student Questionnaire 92
Appendix D: Mathematics Achievement 100
Appendix E: Confidence Intervals for Achievement Results 145
Appendix F: Analysis of Planning Documents 148
Appendix G: Committee Members 154

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This review would not have been possible without the dedication shown by the many individuals who worked on various committees. Members of the main review committees are identified in Appendix G. We also want to thank the Lakehead Board of Education and the Metropolitan Separate School Board for their co-operation in making it possible to have photographs taken in their classrooms.

Executive Summary

Overview

The provincial review of mathematics for Grade 10 (general level) is part of an ongoing program of provincial reviews instituted by the Ministry of Education. These reviews are the primary means by which the ministry carries out its commitment to monitor education in the Province of Ontario and inform the public about the performance of the educational system.

In order to obtain a direct indication of how well Grade 10 (general level) students have achieved the goals of the mathematics program, the Grade 10 (general level) students in 100 English-language schools answered multiple-choice and open-ended questions in numerical methods, algebra, geometry, and applying problem-solving strategies to process problems. Students' ability to do mathematics without the aid of calculators was also assessed.

Questionnaires answered by principals, teachers, and students provided information on teaching practices and student attitudes.

Student Performance on Mathematics Tasks

Grade 10 (general level) students achieved at levels that were judged to be satisfactory or better in the majority of the topics in the course; achievement was rated as *strong* in two topics, *satisfactory* in six topics, and *marginal* in four topics.

Achievement was *strong* in applications of numbers and in statistics; it was *satisfactory* in applications of ratio, rate, and per cent; personal finance and banking; borrowing and saving; graphing; linear equations; and process problems. The following were identified as areas of weakness: powers and square roots; polynomials, formulas, and equations; geometry; and computations without calculators.

Student Attitudes

Most students expressed positive attitudes towards mathematics. The majority thought that mathematics was important for employment, that it was of equal importance for boys and girls, and that it was helpful to them outside of school. Forty-nine per cent of students felt that they were good in mathematics, and 33 per cent felt that mathematics was

difficult. Forty-eight per cent of students liked mathematics. When given a difficult problem, most students attempted a variety of approaches to reach a solution; few students gave up before reaching a solution.

Classroom Activities and Classroom Practices

The most commonly used methods of instruction were chalkboard or projector presentations to the whole class and having students work individually on assignments. Teacher demonstrations with concrete materials were used for an average of 10 per cent of the class time.

Calculators were often used in most classrooms, but most teachers reported that students did not have access to computers. When computers were available, teachers most frequently encouraged students to use them to practise new concepts and as an aid in doing projects.

Most students reported that they frequently worked on mathematics alone and that their teacher frequently taught mathematics to the whole class. More than half of the students never did projects in mathematics, and most students never used a computer in mathematics class.

Thirty-seven per cent of students had computers at home, but only 4 per cent used them for mathematics school work.

Forty-three per cent of students did no mathematics homework, and only 16 per cent spent more than one hour per week on mathematics homework.

Teachers reported that students had the opportunity to learn the course content required to answer most of the questions in the Student Assessment Booklets, except in the area of process problems. Opportunity to learn was highest for algebra; it was also high for numerical methods, but somewhat lower for geometry. On average, 24 per cent of teachers said that they taught the skills necessary to answer the process problems.

It is hoped that this report will encourage discussion about mathematics in Ontario schools. Ontario educators should now take steps to:

- maintain the strengths that were identified by this review of the Grade 10 (general level) mathematics program;
- recommend and implement procedures that will lead to improvement in areas where weaknesses were identified.

1. Purpose of the Review

The provincial review of mathematics for Grade 10 (general level) is part of an ongoing program of provincial reviews conducted by the Ministry of Education. These reviews are the primary means by which the ministry carries out its commitment to monitor education in Ontario and inform the public about the performance of the educational system. They are based on Ministry of Education curriculum guidelines and provide information about program implementation and student achievement. The main purposes of the reviews are to:

- determine the effectiveness of curricula and the level of student achievement at the school, board, and provincial levels;
- provide Ontario educators with information that may be used to make decisions for modifying and improving programs and improving levels of student achievement;
- establish baseline data on both program effectiveness and student achievement against which information generated by future reviews can be compared in order to determine progress;
- provide instruments and procedures that can be used in the future by school boards.

The provincial review of mathematics for Grade 10 (general level) was carried out for two main reasons: first, to generate a profile of the nature of mathematics instruction in the Grade 10 (general level) course in Ontario; and, second, to determine how well students enrolled in this course are achieving the goals of the mathematics program.

The profile of mathematics instruction describes some of the characteristics of students enrolled in mathematics at the general level in Grade 10, their teachers, and the mathematics activities that occur in their classes. It also compares students' achievement on specific tasks with the performance expectations of parents, trustees, and educators.

Relating the profile to our current knowledge of the nature of mathematics and to the Ministry of Education's policy and guidelines on mathematics instruction will assist in identifying the most appropriate directions for mathematics instruction in Grade 10 (general level) courses to follow during the 1990s. The identification of these directions can be facilitated by an analysis of the responses to the Principal Questionnaire, the Teacher Questionnaire, the Student Questionnaire, and the Student Assessment Booklets that were administered as part of this review.

This report presents in detail the results of the provincial review of mathematics for Grade 10 (general level) conducted in the spring of 1990. A summary document, *Mathematics, Grade 10 (General Level): A Report Card for Ontario*, has also been prepared. Parallel reports based on data from French-language schools are also available.

2. Mathematics in Ontario Schools

Mathematics is an essential skill for literate citizens because it is required in all areas of life, including the home and the marketplace as well as the school. It includes the study of patterns, the creation and application of abstract systems, and the use of logical arguments. For these reasons, the study of mathematics is an integral part of the education of all students up to Grade 10. It should help them appreciate the contribution that mathematics has made to the development of civilization, as well as prepare them for postsecondary education and for future careers.

As part of its province-wide responsibility, the Ministry of Education, Ontario, establishes goals, policies, and specific expectations through its curriculum guidelines. The provincial curriculum policy for Ontario programs in the Intermediate and Senior Divisions is outlined in *Ontario Schools, Intermediate and Senior Divisions (Grades 7-12/OACs): Program and Diploma Requirements, 1989,* rev. ed. *(OSIS).* The specific expectations for Grade 10 (general level) mathematics are provided in the curriculum guideline *Mathematics, Intermediate and Senior Divisions, 1985.*

While the ministry sets goals, policies, and specific expectations, it is the responsibility of local school boards to formulate programs that are within the rationale of the provincial policy and, at the same time, reflect local needs and priorities. Teachers, working both individually and as a group under the leadership of the department head, have the task of planning and delivering classroom programs that are specifically adapted to the students for whom they are responsible. This task includes the selection of appropriate teaching strategies, resources, and learning activities.

In the past, research has made significant contributions to the development and implementation of mathematics programs in Ontario's schools. It is expected that the results of this provincial review will be similarly beneficial.

3. Description of the Measures and Samples for the Provincial Review

3.1 The Instruments

This provincial review used the following instruments to create a multifaceted profile of the mathematics experiences of students enrolled in mathematics at the general level in Grade 10: Principal Questionnaire, Teacher Questionnaire, Student Questionnaire, and Student Assessment Booklets. All of these instruments are included in a separate publication entitled *Mathematics, Grade 10 (General Level): Review Instruments*. As well, planning documents were submitted to the ministry for review.

- The **Principal Questionnaire** was used to create a profile of the school environment and curriculum-management practices in the school. The questionnaire covered the following areas: the number of students enrolled in and the time allocated to mathematics instruction, the community served, the procedure for reviewing mathematics programs, and the extent of professional activities in mathematics education.

- The **Teacher Questionnaire** was used to collect information on teaching experience, personal and professional backgrounds of teachers, resources, teaching methods, and evaluation procedures.

- The **Opportunity-to-Learn Form** was used to collect information as to whether or not students had been taught the concepts and skills necessary to answer the questions in the Student Assessment Booklets.

- The **Student Questionnaire** provided information about the background and attitudes of students. Students answered questions about themselves and some of their activities outside of school, their attitudes towards school and mathematics, and what they did during mathematics class. In addition, a section of the Student Questionnaire was used to measure student achievement on skills and concepts without the aid of a calculator (no-calculator questions).

- **Student Assessment Booklets** were used to measure student achievement in mathematics. Each of four different booklets contained questions related to all topics of the mathematics program. Most of these were multiple-choice questions, but five questions in each booklet required a written response. Some of these latter questions required students to supply a numerical response, some required students to complete a graph, some required students to write the algebraic solution for an equation, and others required that students undertake the full solution of a problem. Students were allowed to use calculators in completing the questions in these booklets.

The following objectives of the course were assessed in the provincial review:

- **Numerical Methods**

  — *Number Applications*

    - applying addition, subtraction, multiplication, and division of whole numbers, fractions, decimals, integers, and rational numbers, with and without the use of calculators
    - applying approximation, estimation, rounding, and reasonableness of results to calculations, to measurements, and to problem solving
    - interpolating and extrapolating from tabulated data

  — *Powers and Square Roots*

    - interpreting and evaluating powers of integers with whole-number exponents
    - interpreting and evaluating powers of whole numbers with integral exponents
    - multiplying and dividing numbers by 10, 10^2, 10^3, 0.1, 0.01, and 0.001 by inspection
    - writing large and small numbers in scientific notation; using scientific notation in operations and in solving problems
    - simplifying expressions involving multiplication, division, and powers of powers by writing them as repeated factors and by using the exponent laws

- identifying the positive square roots of perfect squares of numbers from 1 to 144
- finding an approximation of square roots of whole numbers and decimals, using a calculator and appropriate rounding
- substituting in formulas involving square roots

— *Applications of Ratio, Rate, and Per Cent*

- using ratio, rate, and proportion in applications
- solving problems involving per cent

— *Statistics*

- comparing data-gathering methods; identifying the suitability of particular sets of data for a specific purpose
- identifying reasons for sampling and the importance of a good sample
- using samples to estimate the characteristics of a population
- determining the mode, median, and mean; comparing the appropriateness of mode, median, and mean as measures of central tendency
- investigating the effect of changing scale on a graph of statistical data
- critically analysing statistical tables, graphs, and statements

— *Personal Finance and Banking*

- applying record keeping to personal income and expense data, and to personal budgeting
- identifying current practices in the use of banking forms and computerized banking, and the features of different savings and chequing accounts
- applying personal record keeping to the checking of account statements

— *Borrowing and Saving*

- identifying the types of credit, savings, and loans available in the community, and investigating their distinctive features
- calculating the cost of credit in simple borrowing examples involving simple interest or compound interest
- calculating the cost of credit for instalment purchases

- **Algebra**

  — ***Polynomials, Formulas, and Equations***

  - developing formulas from diagrams, numerical charts, and measurement activities
  - adding and subtracting polynomials
  - multiplying a monomial, binomial, and trinomial by a monomial
  - solving linear equations in one variable by the algebraic method
  - substituting in a formula involving up to four variables and solving the resulting linear equation
  - solving problems associated with applications that result in linear equations

  — ***Graphing***

  - drawing graphs of numerical relations (including non-linear relations) using tables of ordered pairs derived from experiments and realistic situations
  - interpolating and extrapolating from graphs, including the reading of fractional and decimal co-ordinates

  — ***Linear Equations***

  - investigating examples of direct and partial variation through graphs and tables, and generating related equations
  - drawing the graphs of linear equations in two variables
  - drawing the graphs of pairs of linear equations to determine their intersection; identifying the solution of a pair of linear equations as the intersection of the graphs
  - solving graphically or numerically problems that can be represented by pairs of linear equations

— *Geometry (Geometric Figures and Properties)*

- investigating the angle of properties of two parallel lines and a transversal (alternate angles and corresponding angles)
- investigating the angle properties of triangles and quadrilaterals (exterior angles, interior angles, and supplementary angles)
- applying the angle properties of parallel lines, triangles, and quadrilaterals in numerical exercises
- applying the Pythagorean theorem
- expressing slope as a ratio, using rise and run
- determining the slope of a line segment, using the co-ordinates of its end-points
- investigating the slope properties of parallel segments and perpendicular segments
- calculating the distance between two points in numerical cases

The following three categories were used to classify questions according to the level of thought required:

- **recognition/recall:** the recognition or recall of a definition, concept, formula, or algorithm
- **comprehension:** the use of a concept, formula, or algorithm in a routine way requiring little analysis
- **application:** the use of a concept, formula, or algorithm in a problem requiring some analysis; the solving of non-routine problems that require the choice of strategy in addition to analysis

Grade 10 (general level) mathematics is designed for students who, while they have successfully completed Grade 8 and Grade 9 (general or advanced level) mathematics, have not shown an interest in or aptitude for the more abstract aspect of these courses. The emphasis throughout the Grade 10 course is on developing mathematical ideas in the context of applications; the abstract aspects of mathematics are de-emphasized.

3.2 Development and Administration of Instruments

The assessment booklets and questionnaires used in the provincial review of mathematics for Grade 10 (general level) were developed by a team of educational experts in the subject of mathematics who collaborated in selecting the areas to be examined and composing the individual questions. Once the booklets were completed, they were presented to an independent panel of consultants, who evaluated their overall validity; that is, the consultants determined whether the questions evaluated students' skill in mathematics at the appropriate level – Grade 10 (general level) – in the designated areas. Following the meeting of the evaluation panel, the questions were pilot-tested to ensure that they were appropriate for Grade 10 (general level) students and free of flaws.

The Student Assessment Booklets were distributed to participating schools for administration in May 1990. The four different booklets were randomly distributed to students in each class so that approximately equal numbers of students within each class would be responding to each booklet. Although a time estimate for completion of the booklets was given, teachers were advised to allow students sufficient time to answer all questions. Students were excluded from the assessment only if they were enrolled in an English-as-a-second-language or a special-education program.

Questionnaires were answered by principals, teachers, and students during April 1990. The Student Questionnaire contained a number of achievement questions that students were to answer without the aid of a calculator. All students answered the same questions.

Students' answers to questions requiring a written response were marked by their classroom teachers. The scoring guide for these questions is given in *Mathematics, Grade 10 (General Level): Review Instruments.*

3.3 Interpretation of Results

An interpretation panel consisting of teachers, administrators, university professors, trustees, and parents reviewed the test questions and results to establish standards and make judgements about student achievement. Panel members are listed in Appendix G.

Establishing Standards

The first task of the panel was to decide what constituted acceptable and desirable levels of performance on the test questions. This determination was based on the members' familiarity with skill levels of Grade 10 (general level) mathematics students and with the Ontario curriculum. When setting these standards, the panel members had no knowledge of students' actual performance levels in responding to the test questions.

To establish these standards, panel members reviewed each of the test questions prior to the tabulation of the results. Members were then asked to determine for each question the percentage of correct answers that would constitute (a) an acceptable level of performance and (b) a desirable level of performance. Acceptable performance was defined as the level of achievement below which a real weakness was indicated. Desirable performance was defined as a higher level of achievement that would indicate a strength. The desirable level was not to be considered an ideal level of achievement.

The panel carried out its task in three stages.

- **Stage 1:** Each panel member was instructed to set acceptable and desirable levels of performance for all questions in the assessment booklets and for no-calculator questions.

- **Stage 2:** Panel members met in small groups to compare their individual ratings, discuss their rationales for them, and arrive at a small-group consensus on the levels of performance for each question.

- **Stage 3:** Once the small groups had arrived at a group consensus, panel members met as one large group. The small-group ratings were shared, and a large-group consensus for acceptable and desirable levels of performance for all questions was established.

This process determined the standards by which assessment outcomes could be judged and rated.

Making Judgements

The mandate of the panel at the second phase of the interpretation process was to create overall ratings of student achievement by examining the standards established during the first phase and the scores achieved by students on each of the questions in the Student Assessment Booklets. For each question, overall student achievement was rated on the following scale:

5 – superior:	This level indicated outstanding student performance, showing a definite strength in the program.
4 – strong:	This level indicated strong student performance and is to be expected if the program has been implemented effectively.
3 – satisfactory:	This level indicated acceptable student performance and is to be expected if the program has been implemented adequately.
2 – marginal:	This level indicated student performance that is slightly less than satisfactory, and points out an area of the program that needs improvement but is not a major weakness.
1 – weak:	This level indicated student performance that is definitely unsatisfactory, and points out a major weakness in the program.

To establish ratings on the five-point scale, the panellists examined each question, the percentage correct on that question, and the acceptable and desirable levels set during the first phase. Once again, a multistage process was used to arrive at a group consensus.

- **Stage 1:** Each panellist assigned a performance rating to each question in the assessment booklets.

- **Stage 2:** The panellists met in small groups to share and discuss their individual ratings and to arrive at a small-group consensus on the rating for each question.

- **Stage 3:** Once the small groups had arrived at a consensus for the ratings on all questions, they met as a large group to arrive at a whole-group consensus for each question.

- **Stage 4:** Following the discussion and establishment of consensus on each question, the whole group was presented with the distribution of question ratings within each of the curriculum areas examined. On the basis of this distribution, the whole group arrived at a single descriptor of student performance for each curriculum area.

The panel generated considerable discussion and debate before a consensus emerged. This discussion assisted in identifying the strengths and weaknesses discussed in "8. Student Achievement".

3.4 Provincial Review Participants

Reviews of mathematics were conducted in both English and French schools. Two different groups were involved in the review: those chosen to constitute the provincial sample and those who opted to participate in board reviews. The present report pertains only to the English-language provincial sample. The results of the French review may be found in *Les mathématiques, 10e année (niveau général) : rapport à l'intention des éducateurs et des éducatrices.*

A sample of 100 schools was randomly selected from the entire population of English-language schools in Ontario offering mathematics at the general level in Grade 10. The data collected from this sample are representative of the entire Grade 10 population taking general-level mathematics. Students taking mathematics in the first semester, students in English-as-a-second-language programs, and students identified as exceptional by an Identification, Placement, and Review Committee did not participate. The number of respondents for each instrument is shown in Table 1. For Student Assessment Booklets, the number of respondents represents the total number of students for all booklets. Since some students answered more than one booklet, this number does not equal that for booklets reported in Appendix D.

Table 1
Number of Respondents

Instrument	*Respondents*
Principal Questionnaire	99
Teacher Questionnaire	167
Opportunity-to-Learn Form	166
Student Questionnaire	4181
Student Assessment Booklets	3831
No-Calculator Questions	4174

Response rates were 99 per cent for the Principal Questionnaire and 97 per cent for the Teacher Questionnaire and Opportunity-to-Learn Form. Based on September enrolments, the response rates for student materials were 77 per cent for the Student Questionnaire and No-Calculator Questions, and 70 per cent for the Student Assessment Booklets.

3.5 Board Review Participants

Forty-eight school boards carried out their own local reviews, using the questionnaires and test booklets created for the provincial review. The board reviews involved all schools offering mathematics at the general level under the jurisdiction of the participating boards. School boards had the option of including exceptional students and students in ESL programs. The board results do not form part of the information provided in this report.

Every school participating in a board review or in the provincial sample was provided with its own results. Board results were provided to those boards that conducted board reviews.

4. Principal Questionnaire

A profile of the school environments in which Grade 10 mathematics is taught at the general level in Ontario can be derived from the information collected by the Principal Questionnaire. The location of the school, and the leadership, the quality of staff, and the use and deployment of resources within it, combine to define the educational framework within which the school operates. The complete Principal Questionnaire and the responses to each question are presented in Appendix A.

4.1 Enrolment

The average enrolment in the schools which formed the sample for the review was 958. Twenty per cent of the schools had an enrolment of fewer than 600 students; 12 per cent had 1500 or more students. The average enrolment in Grade 10 mathematics at all levels was 220 students. The average enrolment in Grade 10 mathematics at the general level was 83 students. For schools in the sample, 38 per cent of the Grade 10 mathematics students were at the general level. For the province as a whole, this percentage would be considerably lower because schools offering only basic or advanced programs were not part of the sample.

4.2 The Location of School and Structure of Program

Sixty-eight per cent of the schools served urban or suburban areas, 29 per cent served rural areas, and 3 per cent served an isolated area.

The average number of hours of mathematics instruction reported was 117 per year. Fifty-five per cent of principals reported an allocation of 110 to 114 hours to mathematics instruction, and 23 per cent reported 120 or more hours.

Most of the mathematics courses taught in Grade 10 (general level) were semestered (72 per cent). The majority of schools (65 per cent) did not have an Immersion French Program. Only 3 per cent of general-level mathematics courses were taught in French.

4.3 Frequency of Staff Meetings on Mathematics

The highest percentage of principals (35 per cent) reported that teachers met once every month or every second month to discuss mathematics programs. Thirty per cent reported that meetings were held once every two or three weeks, and 23 per cent reported that meetings were held once a week.

4.4 Use of Planning Documents

Principals reported that greater emphasis was placed on Ministry of Education guidelines than on board documents. School-level planning documents/courses of study had the greatest emphasis, with 91 per cent of principals reporting that these were used "a lot".

4.5 Reviews of Mathematics Programs

Sixty-six per cent of principals reported that their school boards had a procedure for regularly reviewing mathematics programs. A higher percentage (84 per cent) reported that their schools had a regular procedure. Sixty-eight per cent said that a review had occurred in the previous school year, and 22 per cent said there had been a review in the previous two to four years. These findings suggest that reviews are held on a frequent basis.

The primary emphasis in the reviews was on evaluation practices, although planning documents also received much attention. Teaching practices and resources received nearly equal, high levels of attention. Student-achievement measures were employed in 26 per cent of the mathematics reviews.

Principals reported that the major focus of change resulting from reviews was sequence and timing of programs (83 per cent reported a change). Changes in teaching strategies and student-evaluation practices were also reported by a large number of principals (69 and 71 per cent, respectively).

4.6 Professional Development

According to principals, conferences and professional reading were the most popular means by which teachers engaged in professional development. Principals also reported that teachers attended seminars or workshops. These three activities were reported by more than 80 per cent of principals. Approximately 50 per cent of principals reported that teachers visited other classes or used peer coaching/job shadowing for professional development. Credit courses, which were reported by only 25 per cent of principals, were a low priority among teachers.

5. Teacher Questionnaire

The Teacher Questionnaire and the responses to each question are presented in Appendix B. Teachers were asked background questions and questions about teaching methods, resources, and evaluation strategies.

5.1 Characteristics and Educational Background

A majority of teachers of Grade 10 (general level) mathematics were male (72 per cent). Many had eleven or more years of teaching experience (63 per cent), although a significant number had less experience (10 per cent had one year, 18 per cent had two to five years, and 10 per cent had six to ten years). Most of this experience was gained in secondary school; 87 per cent of teachers had not taught in elementary school. Forty-three per cent of teachers had eleven or more years of experience teaching secondary school, while 30 per cent had two to five years of such experience.

A significantly high percentage of teachers had taken no courses in mathematics methods as part of their education (22 per cent). The highest percentage of teachers (36 per cent) had taken one full course in mathematics methods, and 24 per cent had taken two or more such courses.

Fifty per cent of teachers reported taking five or more full-year university courses in mathematics. Thirteen per cent reported taking no full-year university courses in mathematics; the remainder had taken between one and four courses.

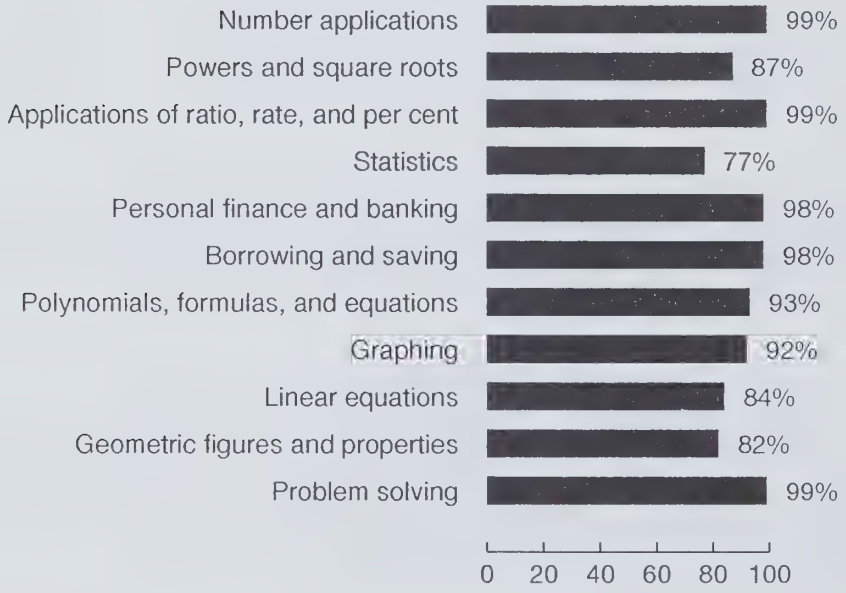
Fifty-five per cent of teachers reported taking one course in measurement and evaluation or testing as part of their teacher training and/or graduate program, and 18 per cent had taken more than one such course. A high number (27 per cent) reported having taken no such course. Most teachers had not had training in the use of computers to teach mathematics (72 per cent).

5.2 Importance of Mathematics Topics

Teachers were asked to rate the importance of instruction of selected topics in mathematics. The percentage of teachers rating each topic as "important" or "very important" is presented in Figure 1. Teachers gave a high priority to the teaching of personal finance and banking (72 per cent reported that this topic was "very important"). On the Student Questionnaire, a high percentage of students reported that they did not study this area. Other topics that teachers felt were very important were borrowing and saving (67 per cent); problem solving (70 per cent); number applications (70 per cent); and applications of ratio, rate, and per cent (67 per cent).

Figure 1
Relative Importance of Selected Mathematics Topics

Percentage of teachers rating each topic as "important" or "very important"



Percentages reported in the graph are based on raw data collected from the Teacher Questionnaire and may vary from the data summary reported in question 8 in Appendix B because of rounding.

5.3 Problem Solving

The average percentage of time devoted to the problem-solving process by teachers was 34 per cent. Teachers overwhelmingly (92 per cent) regarded problem solving as a component to be integrated into the mathematics program throughout the year, rather than as something to be taught as a separate unit. In teaching problem solving, they tried to provide students with a systematic approach (93 per cent) and to teach specific strategies (86 per cent). Eighty-two per cent of teachers also encouraged students to develop their own strategies. Eighty-nine per cent of teachers had students discuss their solutions with each other, and 86 per cent had students write up their solutions or results and present them to the teacher.

5.4 Homework

Forty-two per cent of teachers reported that their students would take one to two hours per week to complete mathematics homework. Forty-six per cent of teachers reported that the students would take less than one hour.

5.5 Use of Calculators and Computers

Most teachers reported that students did not have access to computers (70 per cent). In the classrooms where computers were used, 74 per cent of teachers reported that less than 4 per cent of class time was given to having students use computers. When computers were available, teachers most frequently encouraged students to use them to practise new concepts and as an aid in doing projects.

Teachers reported that calculators were used often in mathematics classes, that is, during every or almost every class (74 per cent), or occasionally, that is, during about half the lessons (21 per cent). Teachers encouraged students to use calculators during tests (95 per cent), to check answers to exercises (93 per cent), and as an aid in doing projects (88 per cent). This last category is interesting; on the Student Questionnaire, very few students reported doing projects in mathematics.

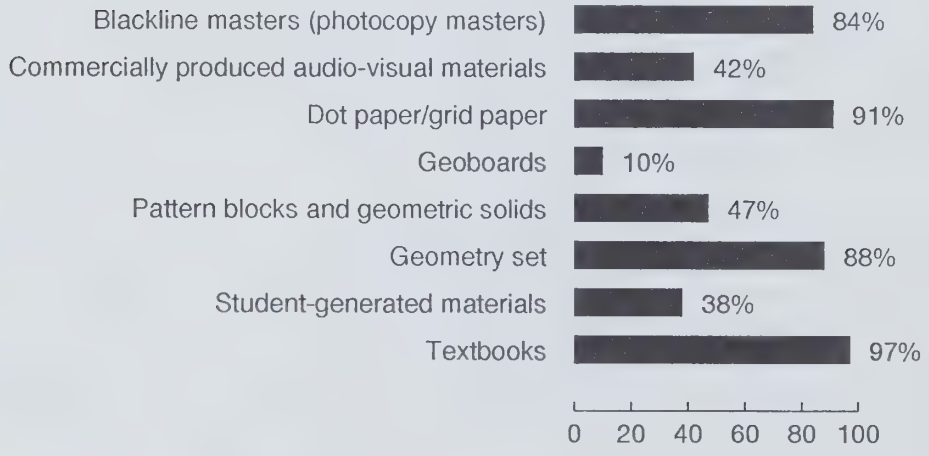
5.6 Instructional Materials

The two resources used most frequently by teachers in preparing lessons were textbooks (65 per cent reported "a lot") and materials prepared by themselves or other teachers in the school (63 per cent reported "a lot"). The Ministry of Education guideline received moderately high emphasis (49 per cent reported "some" use; 47 per cent "a lot" of use). Suggestions from students (59 per cent) and commercially produced supplementary materials (60 per cent) received similar emphasis (i.e., "some" use).

Textbooks, dot paper/grid paper, geometry sets, and blackline masters were the most readily accessible materials for teachers. Teachers emphasized textbooks and blackline masters most heavily in their instruction, followed by geometry sets and dot paper/grid paper. The percentage of teachers who reported placing "some" or "a lot" of emphasis on each resource is presented in Figure 2.

Figure 2
Emphasis Placed on Resources for Teaching Mathematics

Percentage of teachers who placed "some" or "a lot" of emphasis on each resource



Percentages reported in the graph are based on raw data collected from the Teacher Questionnaire and may vary from the data summary reported in question 18 in Appendix B because of rounding.

5.7 Teaching Methods

On average, teachers reported that they used a chalkboard and/or projector 47 per cent of the time. On average, teachers had students working individually for 34 per cent of the time. Teacher demonstrations with concrete materials were used to a lesser extent (an average of 10 per cent of the time).

Thirty-seven per cent of teachers reported that students worked in groups 10 to 19 per cent of the time, and 21 per cent reported that students worked in groups 20 to 29 per cent of the time.

5.8 Evaluation

Teachers were asked what percentage of students' marks was determined through the use of various evaluation tools, including quizzes or short tests, cumulative or end-of-unit tests, formal examinations, observation of student behaviour, peer/self-evaluation, and projects and assignments. Cumulative or end-of-unit tests seemed to bear the most weight, along with formal examinations. Together, they constituted approximately 70 per cent of the final mark. Observation of student behaviour does play a part in evaluation, as does peer/self-evaluation, although these tools carry less weight. On average, quizzes determined 19 per cent of a student's mark, and projects and assignments 11 per cent.

6. Student Questionnaire

The Student Questionnaire and the student responses to each question are presented in Appendix C. Students were asked a series of questions to determine their attitudes towards or enjoyment of various types of mathematics questions, followed by questions on classroom procedures; on the significance of mathematics to their lives, both in and out of school; and on ways in which they deal with mathematics problems that they do not initially understand.

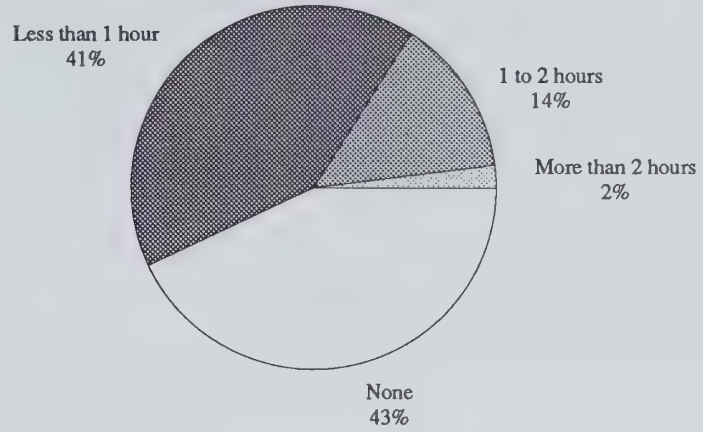
6.1 Background Characteristics

The sample surveyed included a somewhat larger number of males (56 per cent) than females (44 per cent). Fifty-four per cent of students sampled were born in 1974, 30 per cent in 1973, and 15 per cent in 1972 or before. A high percentage (93 per cent) of students declared English to be the language of the home.

6.2 Mathematics Activities Outside School

As shown in Figure 3, many of the Grade 10 students reported doing either no mathematics homework each week (43 per cent) or less than one hour per week (41 per cent). A relatively small number (14 per cent) reported doing one to two hours of homework each week. This result suggests that mathematics assignments are completed within school hours.

Figure 3
Amount of Mathematics Homework Done Each Week



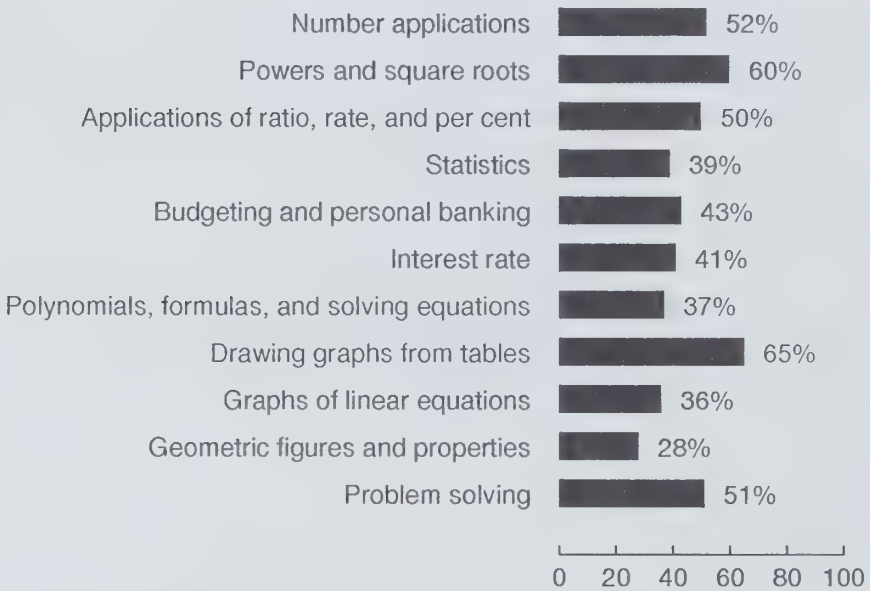
Students reported spending far more time watching television. Thirty-three per cent reported watching for one to two hours per day, and 44 per cent reported watching for more than two hours per day.

When mathematics is done at home, 39 per cent of students reported receiving occasional help from a family member. Fifty-eight per cent of students reported that never, or almost never, did they receive help from a family member. This finding relates to a question, posed later in the questionnaire, in which students were asked whether they would wait and ask someone at home if they did not understand a mathematics problem. Sixty-eight per cent said they would never wait, and 28 per cent said they would sometimes wait. This finding suggests that students do not regard or use family members as a main resource for mathematics problem solving or reinforcement. Mathematics activities related to the school program appear to be tied to the school day.

6.3 Student Attitudes Towards Topics in Mathematics

Students were asked whether they liked doing questions dealing with eleven specific mathematics topics. The percentage of students who said they liked doing questions in a specific topic is given in Figure 4. The majority of students liked doing questions that deal with number applications; powers and square roots; applications of ratio, rate, and per cent; statistics; drawing graphs from tables; and problem solving. When asked if they liked doing questions that deal with polynomials, formulas, and solving equations; graphs of linear equations; and geometric figures and properties, a majority of students said no. The topic with the highest response of "We do not do these kinds of questions" was budgeting and personal banking, which suggests that some teachers did not focus on this area with Grade 10 (general level) students, even though it may be considered of direct relevance to their future use of mathematics skills.

Figure 4
Percentage of Students Who Like Each of Eleven Topics in Mathematics



6.4 What Happens in Mathematics Classes

Students were asked about teaching procedures and student activities in the classroom. Student responses indicate that class time seems to be devoted primarily to presentations to the whole class as a group and work performed by the individual student. Eighty-one per cent of students said that they did mathematics on their own in class almost every day. Sixty-four per cent of students said that they used a calculator almost every day, and 92 per cent said that they never used a computer. Details of responses to questions about classroom activities are provided in Table 2.

Table 2
Percentage of Students Reporting Frequencies of Classroom Activities in Mathematics

	Percentage of Students			
	Almost every day	*Once a week or so*	*Only once in a while*	*Never*
How often do you do mathematics at the board or on the overhead projector?	42	13	26	18
How often is mathematics presented to the whole class as a group?	87	4	5	4
How often do you do mathematics in small groups?	10	8	35	47
How often do you do mathematics on your own in class?	81	7	8	4
How often do you do projects on mathematics topics?	2	4	34	59
How often do you do projects in other subjects that involve the use of mathematics?	6	10	55	28
How often do you write tests or quizzes in mathematics?	12	65	22	1
How often do you use a calculator to do mathematics in class?	64	13	18	5
How often do you use a computer to do mathematics in class?	1	1	6	92

It may be that teachers generally adopt one of two approaches: they have students do mathematics at the board or on the overhead projector frequently, or they do not, as 42 per cent of students responded that they worked in this manner almost every day, whereas 26 per cent responded that they worked this way only once in a while. More students responded that they never worked this way than reported doing so about once a week.

Working in small groups did not seem to be a preferred way of doing mathematics. Forty-seven per cent of students responded that they never worked in this way; 35 per cent responded that they worked in this way only once in a while. Doing projects in mathematics was also rare, as was doing projects in other subjects that involved the use of mathematics. These results suggest that the teaching of mathematics is confined to specific questions or problems set in the class, rather than being applied to or integrated with other curricula.

A majority of students (65 per cent) reported writing tests or quizzes once a week or so, whereas 22 per cent reported doing them only once in a while.

6.5 Use of Calculators and Computers

Many students (64 per cent) reported using a calculator to do mathematics in class almost every day, although more students reported using a calculator only once in a while (18 per cent) than reported using it once a week or so (13 per cent). These findings may suggest that the use of a calculator in school is either a matter of habit or an occasional, deliberate choice. They also suggest that calculator use may be regulated by the teacher, and that some teachers may prefer that students do mathematics calculations unassisted. By contrast, a majority of students (72 per cent) said that they did use a calculator at home.

Most students (92 per cent) reported that they never used a computer to do mathematics in class. Thirty-seven per cent of students reported that they had a computer at home, but only 4 per cent reported using the computer for mathematics school work.

6.6 How Students Feel About Mathematics

Students' perceptions of the significance of mathematics both inside and outside the classroom and students' attitudes towards mathematics were the focus of a series of questions. Most students agreed that mathematics was for everyone equally (94 per cent), although a small group (3 per cent) thought it was more for males than females and another small group (3 per cent) believed the reverse. Most students (75 per cent) thought that mathematics helped them outside of school. Many students (58 per cent) felt that learning mathematics involves mostly memorizing, and a high number (82 per cent) felt that knowledge of mathematics was important in order to get a good job.

Forty-eight per cent of students agreed or strongly agreed that they liked mathematics, whereas 22 per cent were not sure. These results are quite similar to those for the statement "I am good at mathematics". Although many students (49 per cent) reported that they performed well in the subject, a high proportion (33 per cent) felt mathematics was difficult. Details of responses to these attitude statements are presented in Table 3.

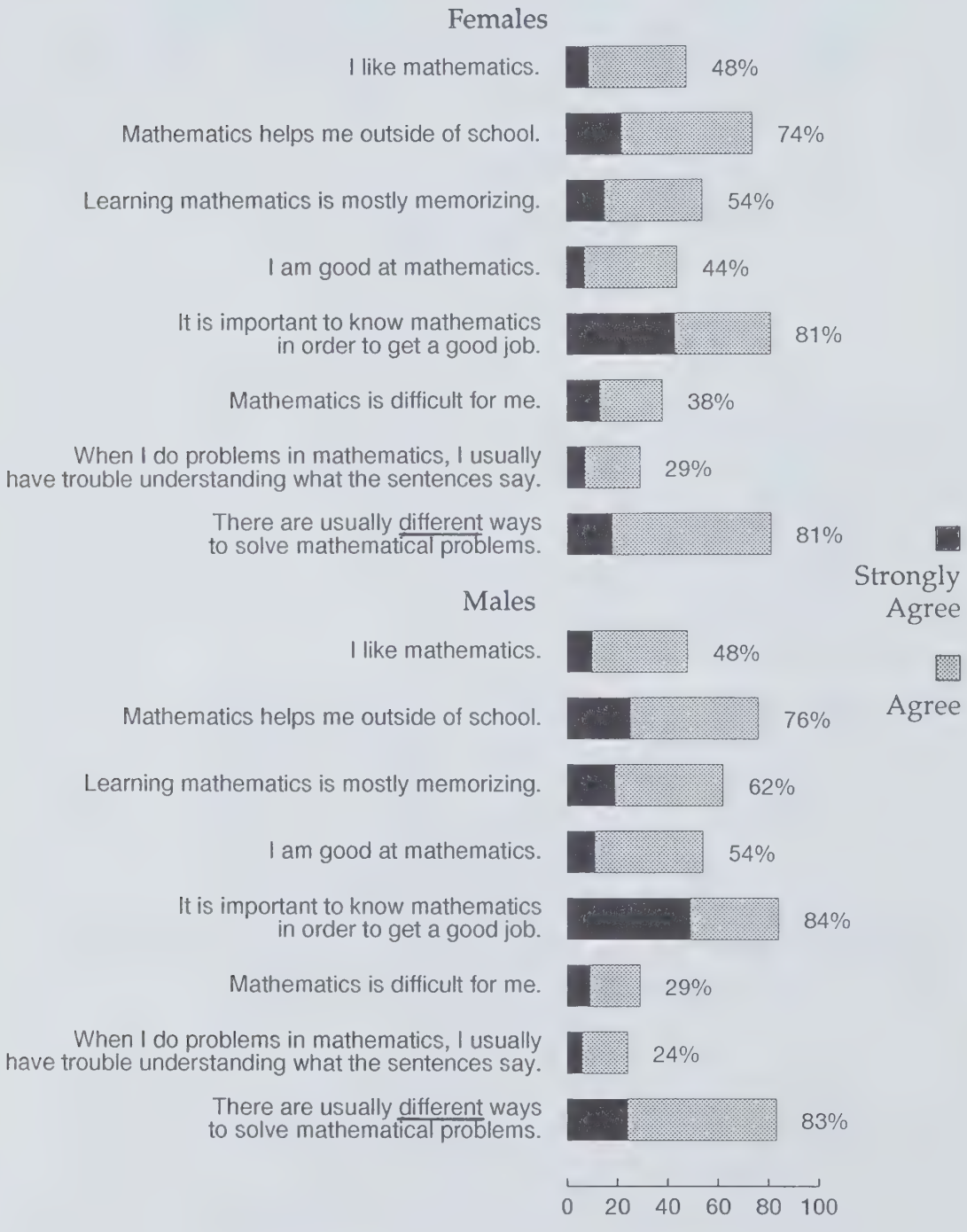
Table 3
Student Responses to Specific Attitudes Towards Mathematics

	Percentage of Students				
	SA	*A*	*NS*	*D*	*SD**
I like mathematics.	10	38	22	18	12
Mathematics helps me outside school.	23	52	12	9	4
Learning mathematics is mostly memorizing.	17	41	19	19	4
I am good at mathematics.	9	40	26	17	8
It is important to know mathematics in order to get a good job.	46	36	9	6	2
Mathematics is difficult for me.	11	22	21	35	11
When I do problems in mathematics, I usually have trouble understanding what the sentences say.	7	20	20	42	11
There are usually different ways to solve mathematical problems.	21	61	14	3	1

**SA* = Strongly Agree; *A* = Agree; *NS* = Not Sure; *D* = Disagree; *SD* = Strongly Disagree

Student attitudes towards mathematics differed in some respects, according to gender. Results by gender are shown in Figure 5. Male and female students appear to like math equally, but male students appear to be more confident about mathematics: a higher percentage of male students than female students (54 as compared to 44 per cent) reported that they were good at mathematics, and fewer male students than female students (29 as compared to 38 per cent) indicated that they found mathematics difficult.

Figure 5
Gender Differences in Student Attitudes Towards Mathematics


Females
I like mathematics.
48%
Mathematics helps me outside of school.
74%
Learning mathematics is mostly memorizing.
54%
I am good at mathematics.
44%
It is important to know mathematics in order to get a good job.
81%
Mathematics is difficult for me.
38%
When I do problems in mathematics, I usually have trouble understanding what the sentences say.
29%
There are usually different ways to solve mathematical problems.
81%
Males
I like mathematics.
48%
Mathematics helps me outside of school.
76%
Learning mathematics is mostly memorizing.
62%
I am good at mathematics.
54%
It is important to know mathematics in order to get a good job.
84%
Mathematics is difficult for me.
29%
When I do problems in mathematics, I usually have trouble understanding what the sentences say.
24%
There are usually different ways to solve mathematical problems.
83%
0 20 40 60 80 100
Strongly Agree
Agree

The percentage of students selecting "strongly agree" and "agree" in response to these opinion statements, by gender, is given in Table 4.

Table 4
Student Responses to Attitude Statements by Gender

	Percentage of Students			
	Female		*Male*	
	SA	*A*	*SA*	*A**
I like mathematics.	9	39	10	38
Mathematics helps me outside of school.	22	52	25	51
Learning mathematics is mostly memorizing.	15	39	19	43
I am good at mathematics.	7	37	11	43
It is important to know mathematics in order to get a good job.	43	38	49	35
Mathematics is difficult for me.	13	25	9	20
When I do problems in mathematics, I usually have trouble understanding what the sentences say.	7	22	6	18
There are usually different ways to solve mathematical problems.	18	63	24	59

**SA* = Strongly Agree; *A* = Agree

6.7 Solving Mathematics Problems

There were two statements on problem solving among the attitude statements reported in Tables 3 and 4 and Figure 5. Fewer than one-third of the students said that they had trouble understanding the sentences used to present problems; 20 per cent said that they were not sure. Most students (82 per cent) recognized that there were usually different ways to solve mathematical problems.

Table 5 tabulates the percentage of responses of students to the series of questions on how they dealt with problems that they did not understand. Most students (90 per cent) responded that they sometimes or often sought help from other students or the teacher when they did not understand a problem in mathematics. Ninety-two per cent said that they tried to solve it on their own.

A fairly high percentage of students (61 per cent) reported that they sometimes or often gave up on problems, although 39 per cent said that they never did. Few students sought help at home.

Table 5
Specific Methods of Dealing With Difficult Mathematics Problems

When you don't understand a problem in mathematics, do you:	Percentage of Students		
	Often	*Sometimes*	*Never*
Try different ways to solve it on your own?	30	62	8
Ask another student for help?	28	62	10
Ask your teacher for help?	29	61	9
Wait and ask someone at home?	4	28	68
Just give up?	9	52	39

7. Planning Documents

As part of the assessment of the intended curriculum in the Grade 10 (general level) mathematics program, courses of study were collected from all schools and boards involved in the provincial sample. These documents were then analysed by a document analysis team of teachers. The purpose of this analysis was to describe what planning documents teachers of Grade 10 (general level) mathematics refer to in preparing their daily lesson plans.

The courses of study that were analysed varied widely in both depth and detail. Some were developed for system-wide use in all schools within a board; others were developed by teachers and/or department heads at a school for use in their own classes. Generally, it was found that, if the course of study had been developed at the board or system level, it was more likely to contain a statement of philosophy, a rationale, and a set of goals; if it had been developed by a teacher for only that teacher's use, it was more likely to be a functional document consisting of a list of required teaching topics, with an emphasis on knowledge and skills.

In some instances, partial documents were sent in for analysis. For example, a curriculum document on intermediate mathematics that included courses from Grades 7 to 10 would have been disassembled and the Grade 10 (general level) course of study submitted separately for analysis. In such a case, the document analysis team was unable to determine whether sections of the document not included, or its introduction, might have contained general information on the teaching of mathematics, evaluation of the program, goals of the intermediate mathematics program, and so on. Furthermore, special documents on evaluation produced by some boards were not submitted because they were not part of the Grade 10 (general level) mathematics course of study. Because of these anomalies, the data gathered from the planning documents should be interpreted broadly. Appendix F contains a detailed summary of the data compiled by the document analysis team.

7.1 Type of Document

Documents were of two types: board level (produced by school boards and designed to be used in all Grade 10 [general level] mathematics classes), and school level (produced in a school for use in only that school). Of the Grade 10 courses of study analysed, fourteen were board level and ninety-eight school level.

7.2 Rationale/Objectives

Half of the school-level courses of study contained a statement of philosophy or rationale. Fifty-seven per cent of the board-level documents included such a statement. Specific objectives of the mathematics program were included more frequently: in 75 per cent of school-level documents and 93 per cent of board-level documents.

The analysis team looked for three types of objectives: skills, knowledge, and attitudes. Skills and knowledge objectives were mentioned in most of the planning documents received; attitudinal objectives in fewer cases. Of school-level documents, 43 per cent mentioned attitudinal objectives; of board-level documents, 77 per cent.

7.3 Content Areas

Most of the documents included in this analysis were based upon the curriculum guideline *Mathematics: Intermediate and Senior Divisions, 1985. Part Two: Grades 9 and 10, General Level*. The guideline lists both compulsory and optional topics. For the most part, board and school documents included all the compulsory topics. Approximately half of the documents listed the optional topics. More board-level than school-level documents listed the optional topics.

Table 6 lists the compulsory and optional topics from the guideline. It shows, for each category, the percentage of documents that included the topic listed.

Table 6
Percentage of School- and Board-Level Documents Dealing With Guideline Topics

Guideline topics	*School-level documents*	*Board-level documents*
Numerical Methods		
Number applications	98	93
Powers and square roots	98	93
Applications of ratio, rate, and per cent	96	93
Statistics	95	93
Personal finance and banking	94	93
Borrowing and saving	96	93
Applied trigonometry (optional)	36	33
Algebra		
Polynomials, formulas, and equations	98	93
Graphing	97	93
Linear equations	97	93
Geometry		
Geometric figures and properties	95	93
Core extension or options	52	58

7.4 Teaching Methods

The majority of board-level documents included some suggestions on teaching methods: they provided specific instructional techniques, learning strategies, lesson plans, sample tasks for students, and various teaching approaches for Grade 10 (general level) mathematics. Instructional methods or teaching strategies were included in 64 per cent of board-level documents and 33 per cent of school-level documents.

7.5 Calculators and Computers

The use of computers in Grade 10 (general level) mathematics classes was discussed in more board-level than school-level documents. While computers are readily available to students, their frequency of use, according to responses to the Student Questionnaire, is very low. Inclusion of computers in the courses of study was correspondingly low (21 per cent of board-level documents and 6 per cent of school-level documents).

7.6 Evaluation Practices

Many boards in Ontario have produced documents dealing specifically with evaluation. Even so, many of the planning documents included additional information for teachers about evaluation related to the Grade 10 (general level) mathematics program. Where evaluation did form part of the document, reference was made to formative and summative techniques.

References to evaluation in both the board- and school-level documents stressed a variety of summative evaluation techniques, such as unit tests, post-tests, examinations, standardized tests, projects, and essays. Observation as a formative evaluation technique was included in many instances, but in more board-level than school-level documents.

7.7 Conclusion

An analysis of the planning documents for Grade 10 (general level) mathematics at the school and board levels reveals that boards have historically invested enormous energy and resources into curriculum development. It also demonstrates that teachers of Grade 10 (general level) mathematics closely follow the provincial guidelines when preparing courses of study for use in the classroom.

8. Student Achievement

A number of instruments were used to determine whether or not students were achieving the goals of the Grade 10 (general level) mathematics program. These instruments included multiple-choice questions, questions requiring short answers, and problems requiring extended responses. Students were allowed to use calculators while working on the majority of the questions; however, eight questions were designed to test students' achievement on skills and concepts when they performed without the aid of a calculator. The following areas of the curriculum were covered by the instruments: numerical methods, algebra, geometry, and process problems. The questions measured students' ability to recall, understand, and apply mathematical facts, skills, and concepts, and to select and carry out a strategy to solve an unfamiliar problem. More detailed descriptions of the assessment instruments and curriculum areas are presented in "3. Description of the Measures and Samples for the Provincial Review".

The results were reviewed by an interpretation panel, which rated student performance on the following five-point scale:

5 – superior
4 – strong
3 – satisfactory
2 – marginal
1 – weak

Student achievement for the majority of the curriculum areas in Grade 10 (general level) mathematics was rated as *satisfactory* or better. Some areas of strength were identified by the interpretation panel. Student performance was rated as *strong* in applications of numbers and statistics.

The following were identified as areas of concern, where improved performance would be desirable:

- powers and square roots
- polynomials, formulas, and equations
- geometric figures and properties
- operations with powers of 10

Questions for each of the areas of the curriculum are presented in Appendix D, along with the percentage of students answering each question correctly and the ratings of the interpretation panel (see Tables D-1 to D-11). The results for each curriculum area are summarized in Table D-15 in (Appendix D).

The four Student Assessment Booklets were randomly distributed within each class so that one-quarter of the students in the provincial sample answered each booklet. Since each student did not answer all questions, there is a degree of uncertainty associated with the provincial statistics (sampling error). The magnitude of this uncertainty for each curriculum area and for individual questions is specified in Appendix E in the form of confidence-band widths. For example, the confidence-band width associated with the mean percentage correct for numerical methods was ±0.5, and the reported mean percentage correct was 65.6. The confidence band for numerical methods was, therefore, 65.1 to 66.1 per cent. The mean percentage correct would fall within this range 95 per cent of the time if the review were repeated with a similar sample.

In the presentation of results, achievement is reported as the average percentage correct for the questions on each topic. Ratings provided by the interpretation panel are also presented. Since the questions on one topic might be considerably more difficult than the questions on another, it is not advisable to compare the results for different topics solely on the basis of average percentage correct. When the interpretation-panel members reviewed the results, they considered the difficulty of the question, the expected performance level for Grade 10 (general level) mathematics students for the question, and the students' actual achievement. On that basis, the panel rated strength and weakness.

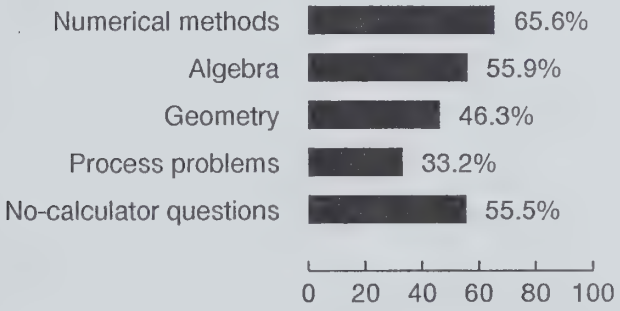
Table 7 indicates the percentage of questions within each area of the curriculum for which student performance was given a particular rating by the interpretation panel. For example, performance on 26 per cent of questions (fifteen of fifty-seven) on numerical methods was rated as *strong*. The panel rated performance as *satisfactory* on 42 per cent of the algebra questions, and as *marginal* on 58 per cent of the geometry questions. Performance on three of the four process problems was rated as *satisfactory*, and performance on four of the eight no-calculator questions was rated as *satisfactory*.

Table 7
Percentage of Questions Within Each Curriculum Area Receiving Each Panel Rating

	Percentage of Questions				
Rating	*Numerical methods*	*Algebra*	*Geometry*	*Process problems*	*No calculator*
Superior	2	2	0	0	0
Strong	26	9	0	0	0
Satisfactory	47	42	17	75	50
Marginal	11	31	58	25	38
Weak	14	16	25	0	12

A summary of the average percentage correct for each curriculum area is presented in Figure 6.

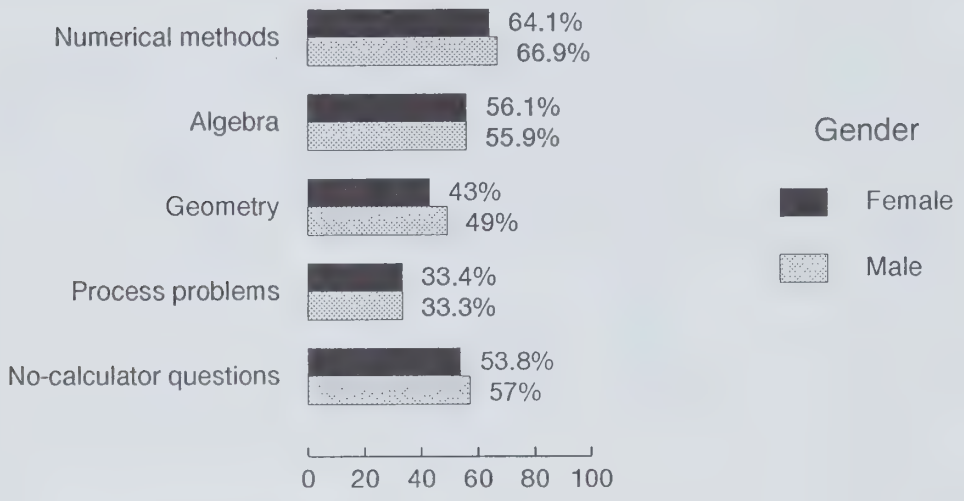
Figure 6
Summary of Mathematics Achievement (Percentage Correct) by Curriculum Area



The panel ratings were: *satisfactory* for numerical methods, *marginal* for algebra, *marginal* for geometry, *satisfactory* for process problems, and *marginal* for no-calculator questions.

The average percentage correct for male and female students is shown in Figure 7. Achievement levels are slightly higher for male students than for female students for all curriculum areas. The enrolment in Grade 10 mathematics at the general level was 56 per cent female and 44 per cent male.

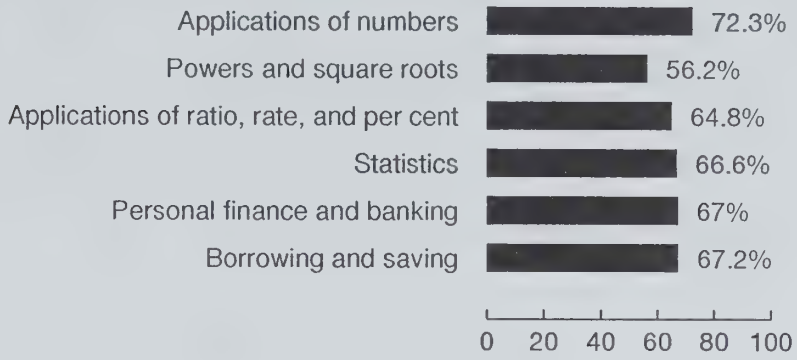
Figure 7
Average Student Achievement for Each Curriculum Area by Gender



8.1 Numerical Methods

By the end of Grade 10 (general level) mathematics, students are expected to use computations with whole numbers, decimals, integers, fractions, and rational numbers in a variety of applications, including ratio, rate, and per cent; personal finance and banking; and borrowing and saving. They also are expected to interpolate and extrapolate from tabulated data; to analyse critically statistical tables, graphs, and statements; and to interpret and apply powers and square roots. Some of the skills associated with this topic were assessed separately through the no-calculator questions. The results for achievement in numerical methods are shown in Figures 8 and 9.

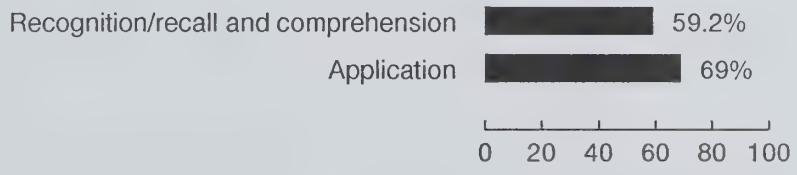
Figure 8
Student Achievement in Numerical Methods by Topic



The interpretation panel ratings were: *strong* for application of numbers and statistics, *marginal* for powers and square roots, and *satisfactory* for the other three topics.

Questions were classified according to the following cognitive levels (described in "3.1 The Instruments"): recognition or recall, comprehension, and application. Averages for percentage correct for the questions in these cognitive levels are presented in Figure 9. As only four questions tested recognition or recall, achievement on questions in numerical methods testing recognition or recall was combined with achievement on questions testing comprehension.

Figure 9
Student Achievement in Numerical Methods by Cognitive Level



Applications of Numbers

Ten questions on the application of numbers were included, and the interpretation panel rated the results as *satisfactory*. The results on five of the questions were rated as *strong* or *superior*, and the results on three questions were rated as *satisfactory*. The performance on one question was rated as *marginal*, and on one as *weak*.

Question 82 had the highest percentage of correct responses (95 per cent); this result was rated as *superior*. This question (reproduced below) tests students' application of integers.

Question 82

The temperature at noon was 13°C. By midnight, it had fallen 19 degrees. The temperature at midnight is:

Student Responses

1%	A)	−32°C
*95%	B)	−6°C
3%	C)	+6°C
1%	D)	+32°C

The interpretation panel noted that students' ability to interpret lengthy questions and to round answers to a specified degree of accuracy was weak. This weakness was illustrated by question 69 (reproduced below). Only 18 per cent of students determined the volume rounded to the nearest cubic metre. An additional 51 per cent calculated the volume correctly, but did not round the answer correctly.

Question 69

The formula for the volume (V) of a rectangular room is V = LWH where length (L), width (W), and height (H) are the room's dimensions.

To determine which air conditioner to buy, Bill needed to know the volume of his room. Its length is 4.0 m, its width is 3.0 m, and its height is 2.4 m. Calculate its volume to the nearest cubic metre.

Student Responses

*18%	right
51%	right, except for rounding
17%	wrong
14%	omit

For question 81 (reproduced below) performance was rated as *marginal.* Ability to interpret questions and select appropriate information may have been a factor.

Question 81

Renata received marks of 13, 16, 15, 16, 14, and 15 on six tests worth 20 marks each. Renata's average mark to one decimal place is:

Student Responses

7%	A)	4.5
*58%	B)	14.8
11%	C)	15.8
22%	D)	89.0
2%	omit	

Powers and Square Roots

The rating given by the interpretation panel to the results for the ten questions on this topic was *marginal.* The results were rated as *weak* for four questions, *marginal* for one question, *satisfactory* for four questions, and *strong* for one question.

While rating the performance in question 83 (reproduced below) as *weak*, the interpretation panel also questioned the relevance of negative exponents in Grade 10 (general level) mathematics.

Question 83

The value of 3^{-2} is:

Student Responses

*21%	A)	$\frac{1}{9}$
7%	B)	$-\frac{1}{9}$
21%	C)	-6
50%	D)	-9
1%	omit	

The poor performance on question 29 (reproduced below) re-emphasizes the weakness in rounding skills evident in the responses to question 69. The interpretation panel suggested that more emphasis should be placed on the teaching of calculator skills, including appropriate rounding of numbers.

Question 29

State the positive square root of 12.59 correct to two decimal places.

Student Responses

*49%	right
36%	wrong
15%	omit

Another question on which performance was rated as *weak* was question 44 (reproduced below). The interpretation panel suggested that students be given more experience in manipulating formulas in applied settings.

Question 44

The radius (r) of a circle is given by the formula $r = \sqrt{\frac{A}{3.14}}$, where A represents the area of the circle.

If the area of a circle is 85 cm^2, the radius is:

Student Responses

5%	A)	0.19 cm
12%	B)	2.9 cm
*35%	C)	5.2 cm
46%	D)	27 cm
2%	omit	

Question 84 (reproduced below) and question 125, for which the performance was rated as *satisfactory*, indicate that the majority of students have mastered the basic properties of exponents.

Question 84

The expression $3^6 \div 3^2$ equals:

Student Responses

8%	A)	3^3
13%	B)	1^3
*62%	C)	3^4
17%	D)	3^8

Applications of Ratio, Rate, and Per Cent

The overall rating for student achievement on this topic was *satisfactory*. Of the eleven questions on this topic, the results were rated as *strong* for two, *satisfactory* for five, *marginal* for two, and *weak* for two.

One of the questions that produced a *strong* rating was question 86 (reproduced below). The other, question 5, involved the interpretation of a scale diagram.

Question 86

In a survey of 120 Grade 9 students, 90 replied that they talked on the telephone at least once a day. What per cent of those surveyed talked on the telephone at least once a day?

Student Responses

3%	A)	25%
8%	B)	30%
*82%	C)	75%
7%	D)	90%

Both questions that produced a *weak* rating and one of the questions that produced a *marginal* rating involved careful reading and a multiple-step solution. One of these was question 45 (reproduced below).

Question 45

A sum of $60 is shared between two people. If the ratio of Gaston's share to Elise's share is 2:3, Gaston's share is:

Student Responses

37%	A)	$20
*33%	B)	$24
11%	C)	$36
18%	D)	$40
1%	omit	

Questions that produced ratings of *satisfactory* also involved careful reading, but solutions were obtained more directly. Question 85 (reproduced below) was one such question.

Question 85

A painter is to mix green and yellow paint in the ratio of 4 to 7 to obtain the colour he wants. If he has 28 L of green paint, how many litres of yellow paint should be added?

Student Responses

20%	A)	16
10%	B)	28
*62%	C)	49
7%	D)	196
1%	omit	

The interpretation panel suggested that this topic should continue to be emphasized because of its practicality.

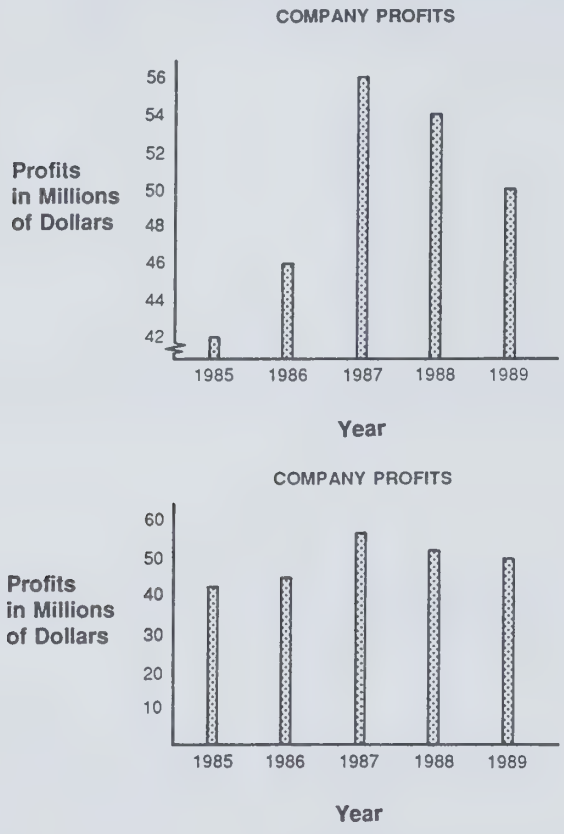
Statistics

This topic included ten questions. The results were rated as *strong* overall. The results for four questions were rated as *strong*, and those for the remaining six as *satisfactory*.

One of the objectives of Grade 10 (general level) mathematics is to encourage students to analyse statistics critically. Question 46 (reproduced below), which was answered correctly by 80 per cent of students, resulting in a *strong* rating, was one of those designed to measure achievement on this objective.

Question 46

The two graphs below show the same data.



Why do the two graphs above give different impressions?

Student Responses

*80%	A)	The scale on the profits axis has been changed.
4%	B)	The scale on the year axis has been changed.
9%	C)	The scales on both axes have been changed.
6%	D)	The graphs represent different information.
1%	omit	

The questions on which students' achievement was lowest dealt with accurate use of the terms *mode, median,* and *mean.* The interpretation panel suggested that such questions should be asked only if the appropriate definitions are supplied with the question. For this reason, the results were rated as *satisfactory* even though the achievement was relatively low. Question 88 (reproduced below) is one of these questions.

Question 88

Seven students wrote a mathematics test marked out of 100.
Their marks were:

71, 72, 72, 79, 87, 90, 96

The median is:

Student Responses

13%	A)	72
*49%	B)	79
35%	C)	81
3%	D)	85
1%	omit	

Personal Finance and Banking

Students in Grade 10 (general level) mathematics are expected to be able to apply record keeping to personal budgeting and to bank-account statements. They are also to be familiar with current practices in the use of banking forms.

Six questions on this topic were included. The interpretation panel rated the overall results as *satisfactory.* One question was rated as *strong,* one as *marginal,* and the remainder as *satisfactory.*

The performance (92 per cent) on question 90 (reproduced below), was rated as *strong.*

Question 90

Llarian had $250 take-home pay from her part-time job during the last month. She used part of the money as shown in the following chart.

CATEGORY	AMOUNT
Savings	$41.35
Transportation	$57.80
Food	$65.10
Entertainment	?

The amount Llarian could spend on entertainment is:

Student Responses

*92%	A)	$85.75
6%	B)	$164.25
1%	C)	$168.45
1%	D)	$208.65

The performance on questions 91 and 131 (reproduced below) seems to be contradictory. Both questions involve the concept of outstanding cheques in record keeping, but student performance differed by 17 per cent. The interpretation panel thought that the discrepancy might be explained by the difference in the format of question 131, where the explanation of "outstanding cheque" is set off more clearly by the use of parentheses.

Question 91

Your bank statement shows a balance of $275.16. A cheque for $20 and a cheque for $10 do not appear on the statement because they are outstanding cheques.

The balance that should appear in your own records is:

Student Responses

*55%	A)	$245.16
2%	B)	$285.16
3%	C)	$295.16
39%	D)	$305.16

Question 131

Your bank statement shows a balance of $374.75. There is one outstanding cheque (one that doesn't appear on the statement) for $80.00 for the purchase of a jacket.

What balance should appear in your own records?

Student Responses

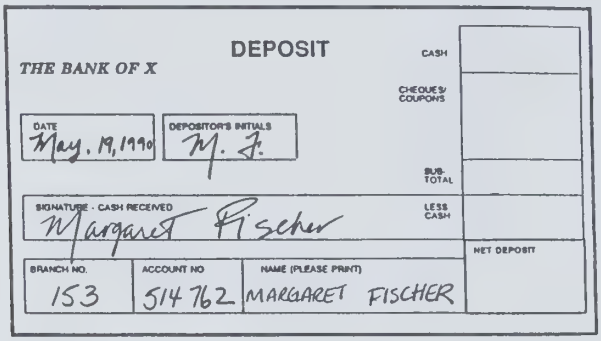
2%	A)	$80.00
*72%	B)	$294.75
9%	C)	$374.75
17%	D)	$454.75

The interpretation panel suggested that question 152, on which performance resulted in a *marginal* rating, may be testing a skill made obsolete by banking machines. This question (reproduced below) required students to complete a deposit slip. While only 36 per cent of students completed *all* parts of the form correctly, 65 per cent filled in the net deposit correctly.

Question 152

Margaret Fischer gets her pay cheque today. Margaret deposits her cheque for $125 less $50 she wishes to keep as cash.

Complete the deposit slip for Margaret.



Student Response (Completes correctly)

52%	Cash (blank)
58%	Cheque amount
57%	Subtotal
73%	Less Cash
69%	Net Deposit
*36%	ALL above completed correctly
18%	No attempt

Borrowing and Saving

Of the ten questions on this topic, the results were rated as *strong* for three, *satisfactory* for five, *marginal* for one, and *weak* for one. The overall rating was *satisfactory*.

The performance on question 13 (reproduced below), one of the questions for which the rating was *strong*, indicates that students understand the concept of simple interest.

Question 13

Todd has an outstanding balance of $350 on his credit card account. The interest charge is 2% per month. The amount of interest that will be charged for one month is:

Student Responses

10%	A)	$0.58
*82%	B)	$7.00
4%	C)	$84.00
4%	D)	$357.00
1%	omit	

The *weak* performance on question 51 (reproduced below) and *marginal* performance on question 12 would suggest that students need further experience with the more complicated situations involving simple interest.

Question 51

Kris borrowed $600 for 4 months at 24%/a. The formula to calculate simple interest on such a loan is: I = prt

The simple interest is:

Student Responses

*33%	A)	$48
29%	B)	$144
10%	C)	$192
27%	D)	$576
1%	omit	

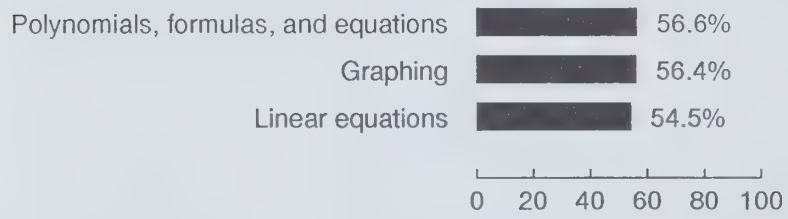
The interpretation panel considered that this topic should continue to be emphasized because of its practical nature. The emphasis should be on the questions that have real applications.

8.2 Algebra

This curriculum area includes addition and subtraction of polynomials, multiplication by monomials, solution of linear equations, substitution in formulas, graphing, interpolation and extrapolation in the reading of graphs, drawing graphs of linear relations, and the graphical solution of pairs of linear equations in two variables.

Although the interpretation-panel ratings on the two topics of graphing and linear equations were *satisfactory*, the *marginal* rating on the topic of polynomials, formulas, and equations was low enough to result in an overall rating of *marginal* for algebra. Averages for the three topics in algebra are given in Figure 10.

Figure 10
Student Achievement in Algebra by Topic



Questions were classified according to the following cognitive levels (described in "3.1 The Instruments"): recognition or recall, comprehension, and application. Averages for percentage correct for the questions in these cognitive levels are presented in Figure 11. As only one question tested recognition or recall, achievement on this question was combined with achievement on questions testing comprehension.

Figure 11
Student Achievement in Algebra by Cognitive Level

Polynomials, Formulas, and Equations

Of the twenty-two questions on this topic, the results were rated as *strong* on two, *satisfactory* on eight, *marginal* on eight, and *weak* on four. The overall rating for the topic was *marginal*. The interpretation panel suggested that more emphasis should be placed, both in teaching and in assessment, on formulas that have "real life" applications and are related to work in other subject areas.

One of the questions for which the results were rated as *strong* was question 94 (reproduced below). This finding indicates that many Grade 10 (general level) mathematics students can model a situation, using algebra.

Question 94

Nigel works in a packaging factory in the summer. He earns $32 per day and a bonus of $2 for each of N orders that he packages.

The formula that describes Nigel's total daily pay (P), in dollars, is:

Student Responses

11%	A)	P = (32 + N)2
16%	B)	P = (32 + 2)N
6%	C)	P = 32N + 2
*66%	D)	P = 32 + 2N
1%	omit	

The results on question 137, rated as *strong*, and on question 97, rated as *satisfactory*, indicate that some of the fundamental procedures of basic algebra are well understood (both questions are reproduced below).

Question 137

$(-5a)(-5a) =$

Student Responses

10%	A)	$-25a^2$
4%	B)	$-10a^2$
8%	C)	$10a^2$
*77%	D)	$25a^2$
1%	omit	

Question 97

The expression $3(5x - 2y + 3)$ equals:

Student Responses

13%	A)	$15x - 2y + 3$
*76%	B)	$15x - 6y + 9$
3%	C)	$-90xy$
7%	D)	$18xy$
1%	omit	

The more complex procedures of algebra show weakness. The results for question 135 were rated as *weak*, and those for question 136 as *marginal* (both questions are reproduced below).

Question 135

$(2a + 3b) - (5a - 2b) =$

Student Responses

13%	A)	$3a + b$
45%	B)	$-3a + b$
14%	C)	$3a + 5b$
*27%	D)	$-3a + 5b$
1%	omit	

Question 136

$-5a\ (3b - 2) =$

Student Responses

*50%	A)	$-15ab + 10a$
14%	B)	$-15ab - 10a$
9%	C)	$-15ab + 2$
25%	D)	$-15ab - 2$
1%	omit	

Achievement in the solution of equations was rated as *marginal*, as illustrated in the results for questions 32 and 151 (question 151 is reproduced below).

Question 151

Solve for x using an algebraic solution.

$$7x - 4 = 2x + 41$$

Student Responses

*47%	Correct answer
18%	Incorrect answer or incomplete, but shows understanding of features of an algebraic solution
10%	Incorrect answer. Does not show understanding of features of an algebraic solution
25%	No attempt

The performance on questions that involved solving an equation after substituting in a formula was also rated as *marginal*. Question 138 (reproduced below) was one such question.

Question 138

P = 2L + 2W is the formula for the perimeter (P) of a rectangle with length (L) and width (W). If P = 34 and W = 7, then L is:

Student Responses

*39%	A)	10
17%	B)	18
33%	C)	20
9%	D)	24
2%	omit	

Graphing

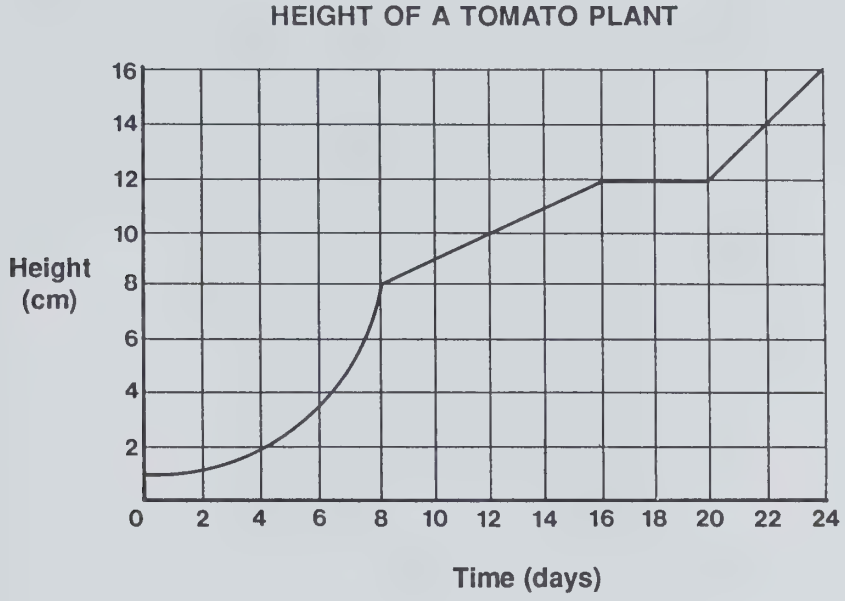
This topic includes the drawing of graphs of non-linear relations and the reading of data from graphs involving interpolation and extrapolation.

The overall rating for the topic was *satisfactory*. Of the ten questions, the results were rated as *superior* for one, *satisfactory* for four, and *marginal* for five. In the opinion of the interpretation panel, students demonstrate good ability with basic graphing skills and concepts, but developmental work needs to be done so that the more complex concepts are mastered.

Question 99 (reproduced below) was answered correctly by 90 per cent of students, and received the *superior* rating.

Question 99

The graph below shows the height of a tomato plant as measured over 24 days for a science project.



During which days did the tomato plant not grow?

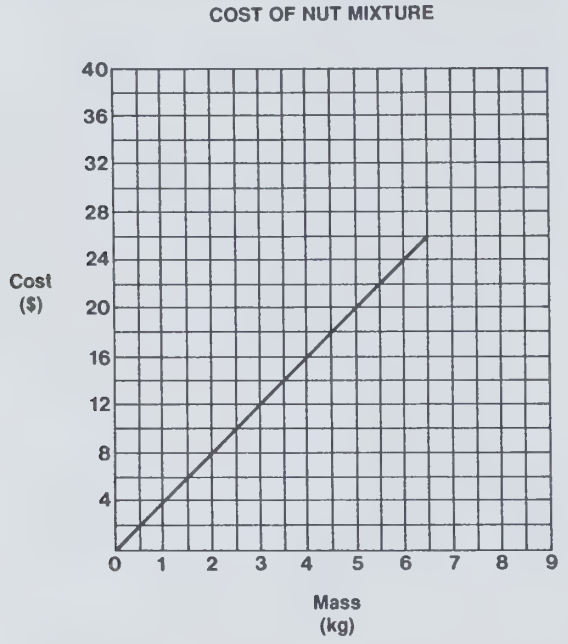
Student Responses

4%	A)	between the 2nd and the 8th day
3%	B)	between the 2nd and the 16th day
2%	C)	between the 20th and the 24th day
*90%	D)	between the 16th and the 20th day
1%	omit	

Student achievement on questions that required extrapolation or interpolation (question 109, reproduced below, is one such question) was about 60 per cent, and was rated as *marginal* by the interpretation panel.

Question 109

The graph below shows the cost of different masses of a nut mixture.



State the cost of 8.5 kg of this mixture.

Student Response

*60%	34 (any number between 33 and 35 was accepted)
31%	wrong
9%	omit

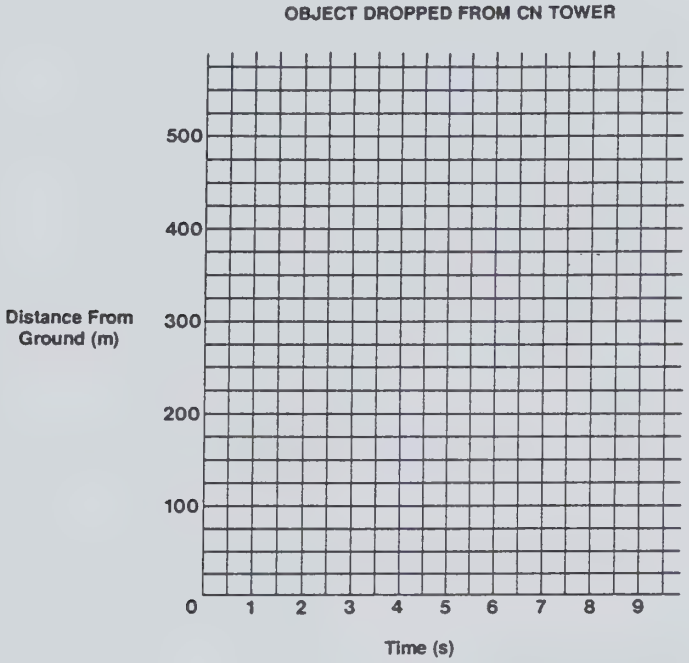
In drawing graphs, students showed *satisfactory* ability in the plotting of points, but the interpretation panel gave a rating of *marginal* for completing the graph, since relatively few students drew a curve through the points. The panel suggested that more attention needs to be given in Grade 10 (general level) mathematics to extending students' understanding of graphs from the broken-line type to the curve. In question 70 (reproduced below), 69 per cent of students plotted the points correctly, but only 46 per cent joined the points with a curve. Twenty-six per cent drew a broken-line graph.

Question 70

An object is dropped from the CN Tower. The table below shows the distance from the ground at different times.

Time(s)	1	3	5	7	9
Distance from the ground (m)	435	405	325	205	45

Graph the relation on the grid below.



Student Responses

69%	plots all points within acceptable range
46%	draws curve through points
26%	draws a broken-line graph
2%	draws a line of "best fit"
19%	omit
*34%	plots points correctly and draws a curve

Linear Equations

The interpretation panel rated the results on the fifteen questions on this topic as *satisfactory*. The results were rated as *satisfactory* for seven of the questions, *strong* for two, *marginal* for three, and *weak* for the remaining three.

Question 100 (reproduced below) resulted in a *strong* rating, with 55 per cent of students answering it correctly.

Question 100

Read the following chart.

Number of Extra Toppings (n)	Cost of Pizza in Dollars (c)
0	8.00
1	8.50
2	9.00
3	9.50

The formula that relates the cost (c) of pizza in dollars to the number (n) of extra toppings is:

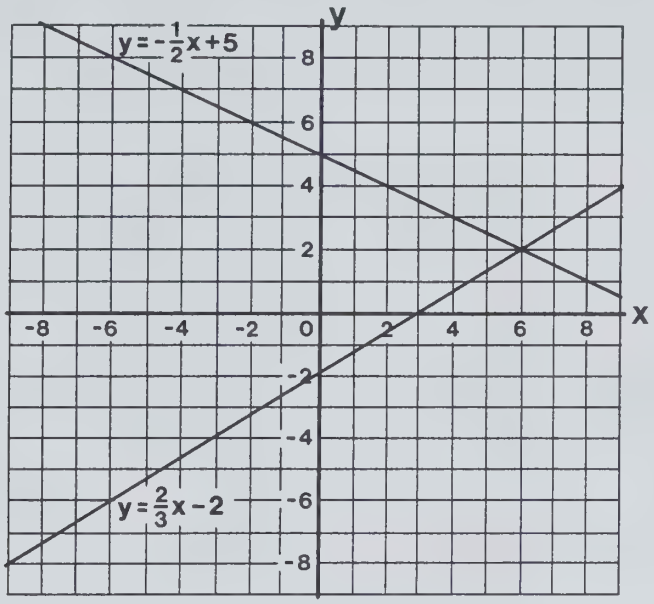
Student Responses

12%	A)	$c = 8.50n$
15%	B)	$c = 8.00n + 0.50$
*55%	C)	$c = 8.00 + 0.50n$
17%	D)	$c = n + 8.50$
1%	omit	

Although 77 per cent of students answered question 22 (reproduced below) correctly, the interpretation panel rated the results as only *satisfactory*, since 12 per cent of students reversed the coefficients.

Question 22

Two straight lines are shown on the graph below.



The point of intersection of the two lines $y = -\frac{1}{2}x + 5$ and $y = \frac{2}{3}x - 2$ is:

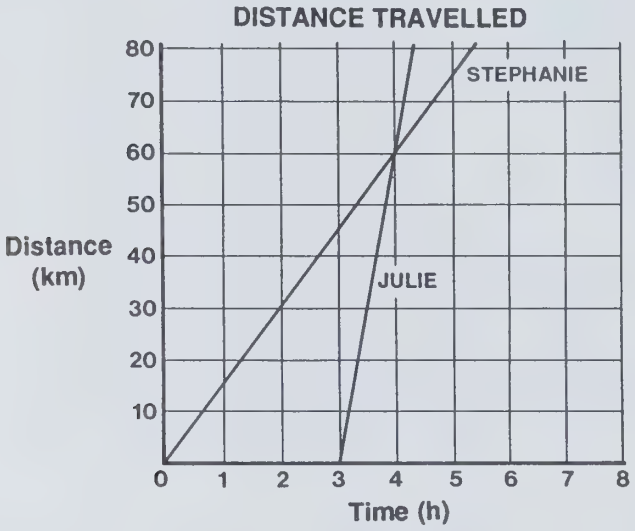
Student Responses

3%	A)	(3, 0)
7%	B)	(0, 5)
*77%	C)	(6, 2)
12%	D)	(2, 6)
1%	omit	

Sixty-seven per cent of students were able to interpret a graph involving the intersection of two straight lines in an applied setting, as shown by question 31 (reproduced below). This result was rated as *satisfactory*.

Question 31

Stephanie and Julie decided to travel the 90 km to their cottage one weekend. Stephanie rode a bike at an average speed of 15 km/h. Three hours after Stephanie left, Julie got in her car and drove along the same route at an average speed of 60 km/h. The graph below shows the distance each had travelled and the number of hours travelled.



When Julie catches up to Stephanie, how many hours has Stephanie been travelling?

Student Responses

*67%	right
22%	wrong
11%	omit

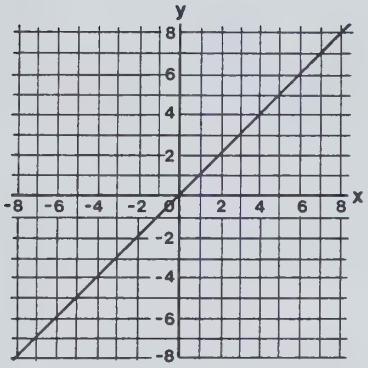
The questions for which the results were rated as *weak* all involved graphing a straight line, given its equation. Question 140 (reproduced below) is one of these.

Question 140

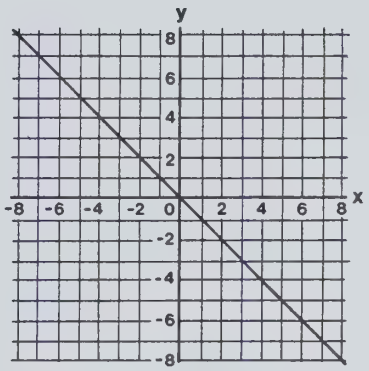
The graph of $y = x + 5$ is:

x	y

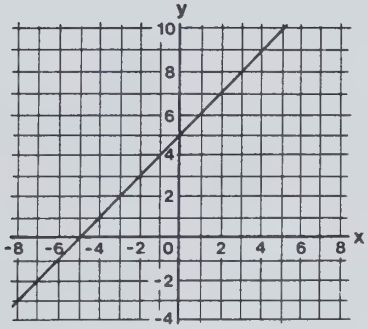
A)



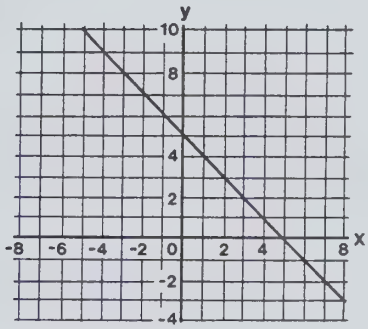
B)



C)



D)



Student Responses

15%	A)
11%	B)
*43%	C)
28%	D)
3%	omit

The interpretation panel suggested that the abstract treatment of linear equations may not be appropriate for Grade 10 (general level) mathematics. The graphs of linear equations should be developed through a study of patterns arising in practical settings.

8.3 Geometry

Grade 10 (general level) mathematics students use the angle properties of parallel lines, triangles, and quadrilaterals to solve numerical problems. They also use the Pythagorean theorem in applications. These are concepts they have used in previous grades. New work involves the concepts of co-ordinate geometry: slope of a line segment, slope properties of parallel and perpendicular line segments, and the calculation of the distance between two points.

The average percentage correct in geometry was 46. The interpretation panel rated student achievement in geometry as *marginal*. Of the twenty-four questions on geometry, fourteen were rated as *marginal*, six as *weak*, and four as *satisfactory*.

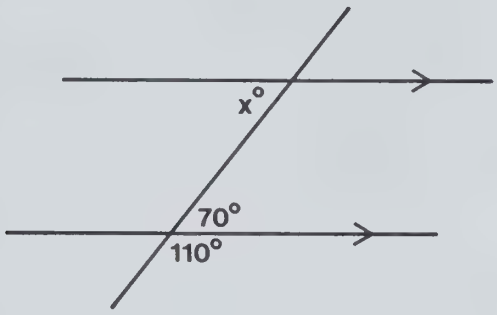
The curriculum guideline *Mathematics, Intermediate and Senior Divisions, 1985* does not list any sections for the geometry strand of Grade 10 (general level) mathematics. For this reason, this report does not contain an analysis of achievement in geometry by topic.

There was no analysis made of geometry by cognitive level since only two questions were classified as requiring recognition or recall, and only three questions as requiring application.

Of the thirteen questions on the angle properties of figures, the results on three (of which question 143, reproduced below, is an example) were rated as *satisfactory*.

Question 143

Examine the figure below:



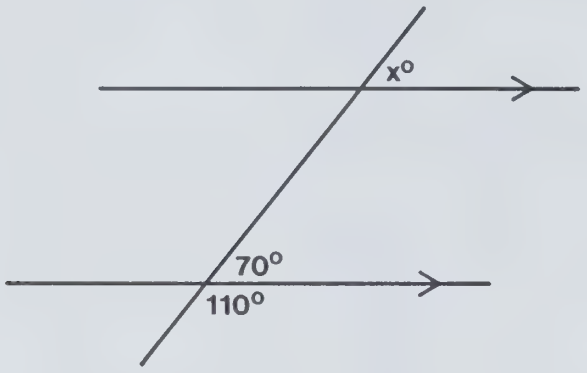
The value of x is:

Student Responses		
13%	A)	110°
*70%	B)	70°
13%	C)	40°
3%	D)	20°
1%	omit	

The results on the remaining questions on angle properties were rated as *marginal*. Questions 23 and 104 (reproduced below) were two of these questions.

Question 23

Examine the figure below:



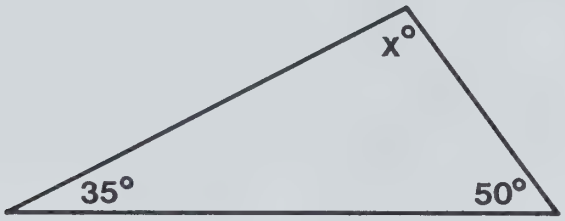
The value of x is:

Student Responses

4%	A)	20°
16%	B)	40°
*68%	C)	70°
11%	D)	110°
1%	omit	

Question 104

Examine the triangle below:



The value of x is:

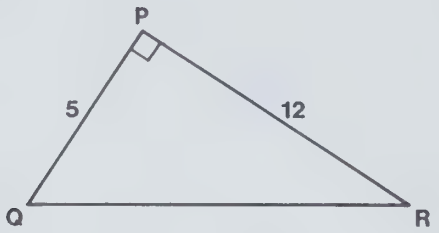
Student Responses

25%	A)	85°
*66%	B)	95°
6%	C)	130°
2%	D)	145°
1%	omit	

There were four questions on the Pythagorean theorem. The results on two of these, questions 26 and 146, were rated as *marginal* and on the remaining two, questions 27 and 64, as *weak*. Questions 27 and 146 are reproduced below.

Question 27

Examine the triangle below:



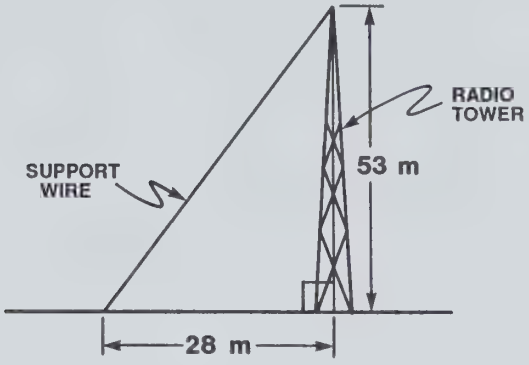
The length of QR is:

Student Responses

14%	A)	7
8%	B)	11
*39%	C)	13
38%	D)	17
2%	omit	

Question 146

The diagram below shows a radio tower.



The length of the support wire for the radio tower is approximately:

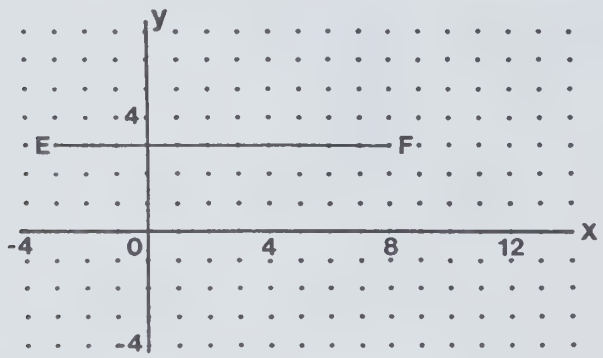
Student Responses

8%	A)	25 m
10%	B)	45 m
*41%	C)	60 m
39%	D)	81 m
2%	omit	

Seven of the questions on geometry were designed to test students' understanding of the slope. The results on question 148 (reproduced below) were rated as *satisfactory*.

Question 148

Examine the graph below:



The slope of EF is:

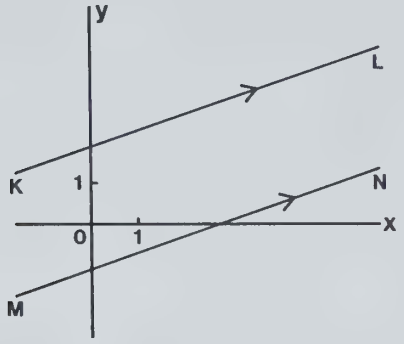
Student Responses

*63%	A)	0
14%	B)	$\frac{1}{8}$
7%	C)	1
14%	D)	8
2%	omit	

The results on two of the remaining questions were rated as *marginal*, and on three as *weak*. Question 108 was one of the questions for which the results were considered *marginal*, and question 107 was one for which the results were rated as *weak* (these two questions are reproduced below).

Question 108

In the diagram below, MN is parallel to KL and the slope of KL is $\frac{1}{3}$.



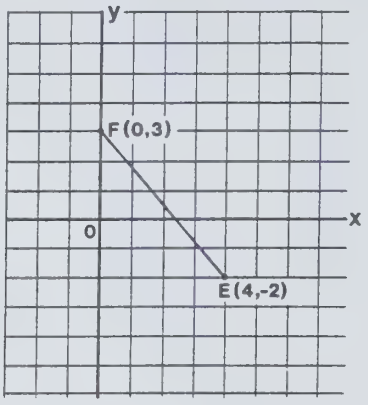
The slope of MN is:

Student Responses

10%	A)	3
*57%	B)	$\frac{1}{3}$
24%	C)	$-\frac{1}{3}$
7%	D)	-3
3%	omit	

Question 107

Examine the graph below:



The slope of EF is:

Student Responses

*24%	A)	$-\frac{5}{4}$
33%	B)	$-\frac{4}{5}$
23%	C)	$\frac{4}{5}$
17%	D)	$\frac{5}{4}$
2%	omit	

The interpretation panel suggested that more emphasis should be given to practical examples in geometry, in general, and, particularly, in relation to the Pythagorean theorem. They also suggested that questions requiring students to use algebra in solving a geometry problem might be inappropriate for Grade 10 (general level).

8.4 Process Problems

The four questions of this type assessed students' ability to apply problem-solving strategies to non-routine problems. Students of Grade 10 (general level) mathematics are expected to be familiar with the following strategies: searching for a pattern, drawing a diagram, constructing a table, estimating, choosing mathematical operations and sequencing them, assuming a solution and working backwards, using a formula or writing an equation, and making an assumption and drawing a conclusion. In solving a process problem, they should be able to select one of these strategies and use it to arrive at an answer. The strategies used by students to solve each problem are summarized in Table D-12 (Appendix D).

The overall rating for student achievement on process problems was *satisfactory*. The results on three questions were rated as *satisfactory*, and on one question *marginal*. Question 113 (reproduced below) had a student-performance rating of *satisfactory*. Thirty-six per cent of students answered this question correctly, and a further 12 per cent solved the question, except for a minor error.

Question 113

On a beach during the summer, Nina collected white and pink shells. On the first day, she found 2 white shells and 1 pink shell. On the next day, she found 4 white shells and 4 pink shells, and on the third day she found 6 white shells and 7 pink shells. If this pattern continued, on what day did she find 6 more pink shells than white shells?

Student Responses

*37%	right
12%	right, except for a minor error
24%	wrong
26%	omit

For question 33 (reproduced below), the results were judged to be *marginal*. Forty-eight per cent of students answered this question correctly, and 8 per cent made only a minor error.

Question 33

Matchsticks are arranged as follows:

FIGURE 1

FIGURE 2

FIGURE 3

If the pattern is continued, how many matchsticks are used in making the 10th figure?

Student Responses

*48%	right
8%	right, except for a minor error
31%	wrong
12%	omit

The interpretation panel suggested that students should be given more experience with process problems to develop their thinking skills. Use of manipulatives should be encouraged in relation to these problems. Where possible, process problems should be related to regular curriculum content.

8.5 No-Calculator Questions

These eight questions were designed to test students' knowledge of operations with rational numbers, multiplication and division by powers of ten, and reasonableness of results.

The interpretation panel rated the results on four of the question as *satisfactory*, on three as *marginal*, and on one as *weak*. The overall rating for this set of questions was *marginal*.

Three of the questions for which the results were rated as *satisfactory* were those testing operations with rational numbers. The interpretation panel suggested that the current emphasis on this topic was sufficient. Question 52 (reproduced below) was one of these questions.

Question 52

Calculate $-\frac{3}{4} + \frac{1}{2}$.

Student Responses

*63%	A)	$-\frac{3}{2}$
21%	B)	$-\frac{3}{8}$
6%	C)	$\frac{3}{8}$
9%	D)	$\frac{3}{2}$
1%	omit	

The three questions for which the results were rated as *marginal* and the question on which student achievement was rated as *weak* tested skill with multiplication with powers of ten. The interpretation panel recommended that these skills be given more emphasis because of their relationship with scientific notation. Fifty-seven per cent of students answered question 55 (reproduced below) correctly, a result rated as *marginal* by the interpretation panel.

Question 55

$23.857\ 6 \times 10^3$ is:

Student Responses

14%	A)	0.023 857 6
14%	B)	23.857 600 0
*57%	C)	23 857.6
14%	D)	238 576 000

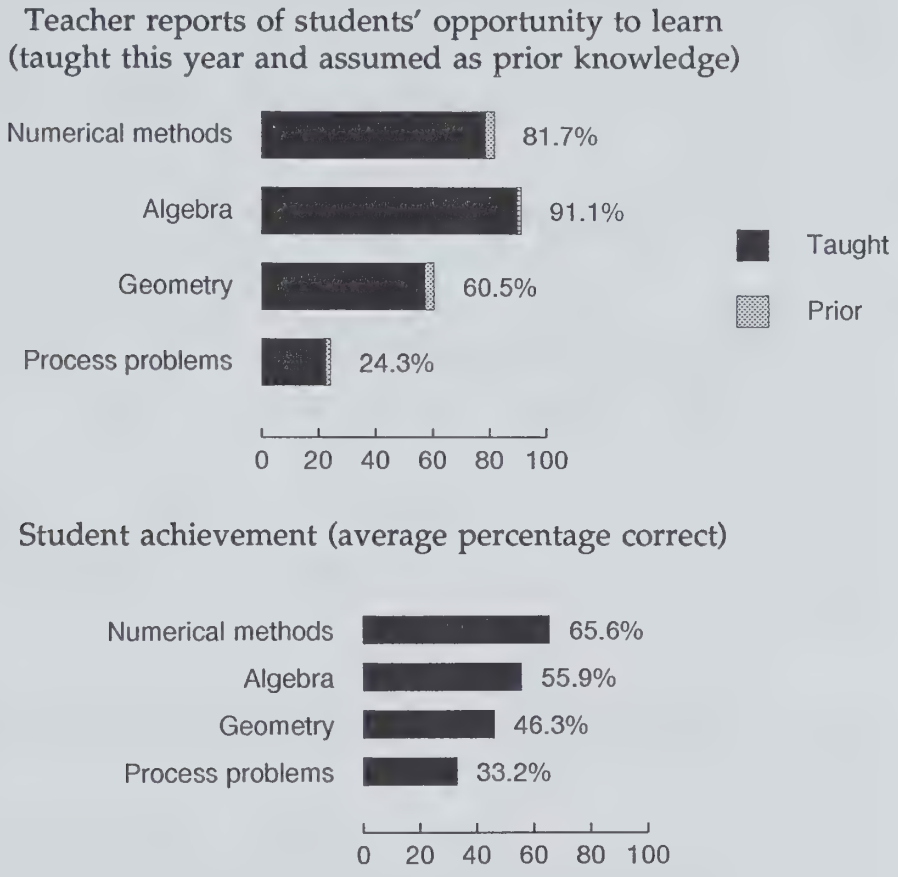
8.6 Opportunity to Learn

Teachers were asked to indicate whether or not they had taught the content required to answer each question in numerical methods, algebra, geometry, and process problems. The results for each question are presented in Tables D-1 to D-11 in Appendix D. The summary data for each curriculum area are provided in Table D-15. Teachers who did not teach the content for a question were asked to indicate reasons for not teaching it. Results for each question are presented in Table D-16 in Appendix D.

The results for opportunity to learn and actual student achievement are summarized in the graphs in Figure 12. The graph for opportunity to learn shows the percentage of teachers who said that they taught the concepts or thought that the concepts had been taught in a previous year. These are the average percentages for all questions in each topic.

Students had a high opportunity to learn the concepts in numerical methods and algebra, but a lower opportunity to learn the concepts in geometry. Only 24 per cent of teachers taught the skills required for the process problems, which may account for the low student achievement in that curriculum area.

Figure 12
Summary of Results for
Opportunity to Learn (OTL) and Achieved Percentage Correct



9. Summary and Conclusions

This comprehensive review of the Grade 10 (general level) mathematics program in Ontario generated a wealth of information on student achievement, student attitudes, program planning, teaching resources and practices, and the context within which the program is delivered. A detailed examination of the information at the provincial, school board, and school levels will provide guidance on how to maintain existing strengths and how to generate improvement in areas where weaknesses were identified.

9.1 Student Achievement

Grade 10 (general level) students in Ontario achieved at levels that were rated as *satisfactory* or better for the majority of the curriculum areas. The strongest student performance was in the area of numerical methods. Students demonstrated a high level of competence in the applications of numbers and in statistics.

Student performance in the following areas was judged to be *satisfactory*: applications of ratio, rate, and per cent; personal finance and banking; borrowing and saving; graphing; linear equations; and process problems.

A *marginal* rating was given to student achievement in powers and square roots; polynomials, formulas, and equations; geometry; and no-calculator questions.

Teachers reported that students had the opportunity to learn the course content required to answer most of the questions in the Student Assessment Booklets, except in the area of process problems. Opportunity to learn was highest for algebra; it was also high for numerical methods, but somewhat lower for geometry. On average, 24 per cent of teachers said that they taught the skills necessary to answer process problems.

Although the average percentage correct on process problems was 33 per cent, this was rated as *satisfactory* because the panel felt that these types of problems are not important for general-level students.

9.2 Student Attitudes

Most students expressed positive attitudes towards mathematics. Eighty-two per cent thought that mathematics was important for employment, 75 per cent said that mathematics helps them outside of school, and 94 per cent thought it was of equal importance for boys and girls. Forty-nine per cent of students felt that they were good in mathematics, and 33 per cent felt that mathematics was difficult. Forty-eight per cent of students liked mathematics. The mathematics topics that were liked by more than 50 per cent of students were drawing graphs from tables, powers and square roots, number applications, and problem solving. When given a difficult problem, most students attempted a variety of approaches to reach a solution; few students gave up before reaching a solution.

9.3 Classroom Activities and Classroom Practices

The most commonly used methods of instruction were chalkboard or projector presentations to the whole class and having students work individually on assignments. These activities accounted for over 80 per cent of class time. Teacher demonstrations with concrete materials were used for an average of 10 per cent of class time.

More than 90 per cent of teachers said that calculators were used in almost every class or during about half of the classes. Ninety-five per cent said that calculators were also used for tests. Seventy per cent of teachers reported that students did not have access to computers. When computers were available, teachers most frequently encouraged students to use them to practise new concepts and as an aid in doing projects.

Most students reported that they frequently worked on mathematics alone and that their teacher frequently taught mathematics to the whole class. Over half of the students never did projects in mathematics, and most students never used a computer in mathematics class. Thirty-seven per cent of students had computers at home, but only 4 per cent used them for mathematics school work.

Forty-three per cent of students did no mathematics homework, and only 16 per cent spent more than one hour per week on mathematics homework.

It is hoped that this report will encourage discussion about mathematics in Ontario schools. Ontario educators should now take steps to:

- maintain the strengths that were identified by this review of the Grade 10 (general level) mathematics program;
- recommend and implement procedures that will lead to improvement in areas where weaknesses were identified.

Appendix A: Principal Questionnaire

The percentage of principals selecting each response for each question on the Principal Questionnaire is presented in this appendix. The percentages are based on the number of principals answering a specific question. The number of respondents is given for each question.

Many questions on this questionnaire asked for information about all three grade levels (Grades 8, 10, and 12). Only the data for Grade 10 are reported in this appendix. Questions 2 and 4, which apply to Grades 8 and 12, have been omitted.

If a large number of numerical responses was possible for a given question, these have been grouped into categories. The data for these questions represent the percentage of principals giving responses that fall in each category. The average of all responses is also given.

Question 1, concerning the number of students enrolled in the school, is an example of this type of question. The first category is 0-299 students. In the province, 3 per cent of principals said that there were fewer than 300 students enrolled in their schools; 33 per cent of principals said that there were 900-1199 students enrolled in their schools. The average number of students in all schools in the province is 958.

1. How many students are enrolled in your school?

No. of Students	*% of Principals*		
0-299	3%	Average	
300-599	17%	number of	
600-899	26%	students:	958
900-1199	33%		
1200-1499	10%		
1500 or more	12%		N = 94

Note: Question 2 applies to Grade 8 only, and question 4 applies to Grade 12 only.

3. How many students are enrolled in the following in your school?
(Include both semesters if applicable.)

Grade 10 Mathematics, Basic, General, and Advanced Levels

No. of Students	*% of Principals*		
0-49	2%	Average	
50-99	7%	number of	
100-149	13%	students:	220
150-199	26%		
200-299	39%		
300 or more	13%		N = 94

Grade 10 Mathematics, General Level only

No. of Students	*% of Principals*		
0-24	8%	Average	
25-49	13%	number of	
50-74	25%	students:	83
75-99	26%		
100 or more	28%		N = 97

Percentage of Grade 10 mathematics students who are in the general level: 38.2%.

5. What is the time allocation for mathematics instruction in your school?

No. of Hours per Year	*% of Principals*		
0-109	0%	Average	
110-114	55%	number of	
115-119	22%	hours:	117
120 or more	23%		N = 96

6. Which of the following best describes the community served by your school?

Urban/suburban area	68%	
Rural area	29%	
Isolated area	3%	N = 99

7. Which of the following applies to the scheduling of your mathematics program?

Full year	28%	
Semestered	72%	
Other	0%	
Both	0%	N = 98

8. a) Is there an Immersion French or Extended French program in your school?

Yes	35%	
No	65%	N = 98

b) If Yes, is Grade 10 mathematics, general level, taught in French?

Yes	3%	
No	97%	N = 32

9. About how often do teachers in your school meet for the purpose of discussing the teaching of mathematics?

Once every week	23%	
Once every two or three weeks	30%	
Once every month or second month	35%	
Fewer than 5 times per year	10%	
Never	1%	
Only one teacher in the school	0%	N = 96

10. How much emphasis is placed on the following planning documents for mathematics?

	None	*Some*	*A Lot*	
Ministry of Education guidelines	0%	22%	78%	N = 98
School board documents	15%	34%	51%	N = 97
School-level planning documents/course of study	1%	8%	91%	N = 98

11. Does your school board have a procedure for regularly reviewing mathematics programs?

Yes	66%	
No	34%	N = 99

12. Does your school have a procedure for regularly reviewing mathematics programs?

Yes	84%	
No	16%	N = 98

13. When was the mathematics program last reviewed by either the school or the school board?

Has not occurred	6%	
Last school year (1988-89)	68%	
Two to four years ago	22%	
Five years or more	2%	
Currently	2%	N = 99

14. If a mathematics review was conducted, which of the following components did it include?

	Yes	*No*	
Review of planning documents	90%	10%	N = 91
Review of teaching practices	79%	21%	N = 90
Review of evaluation practices in schools	91%	9%	N = 92
Review of resources	80%	20%	N = 90
Administration of achievement test	26%	74%	N = 82

15. What changes occurred as a result of the last review of the mathematics program?

	Yes	*No*	
There was a change in:			
Teaching objectives	62%	38%	N = 88
Sequence and timing of programs	83%	17%	N = 89
Teaching strategies	69%	31%	N = 89
Student evaluation practices	71%	29%	N = 89
School resources	51%	49%	N = 85

16. Outside of regular professional development days, what activities or courses do teachers in your school engage in for the purpose of professional development for the teaching of mathematics?

	Yes	*No*	
Seminars/workshops	81%	19%	N = 98
Visiting other classrooms	56%	44%	N = 90
Conferences	87%	13%	N = 97
Peer coaching/job shadowing	42%	58%	N = 89
Credit courses	25%	75%	N = 85
Professional reading	92%	8%	N = 91

Appendix B: Teacher Questionnaire

The percentage of teachers selecting each response for each question on the Teacher Questionnaire is presented in this appendix. The percentages are based on the number of teachers answering a specific question. The number of respondents is given for each question.

If a large number of numerical responses was possible for a given question, these have been grouped into categories. The data for these questions represent the percentage of teachers giving responses that fall in each category. The average of all responses is also given. Question 19, which is reproduced below, is an example of this type of question.

---

19. What percentage of time is devoted to the problem-solving process?

% of Time	*% of Teachers*		
0-19%	17%	Average	
20-29%	27%	percentage	
30-39%	22%	of time:	34%
40-49%	7%		
50-59%	12%		
60% or more	15%		N = 162

In the province, 17 per cent of teachers said that they spent less than 20 per cent of their class time on the problem-solving process in mathematics; 15 per cent of teachers said that they spent 60 per cent or more of their class time on problem solving. The average percentage of time spent on problem solving by teachers in the province was 34 per cent.

Section 1: PERSONAL/PROFESSIONAL BACKGROUND

1. **Are you male or female?**

Male	72%
Female	28%

N = 166

2. **How many years' full-time teaching experience do you have?** ***(Include the current year and round to the nearest year any part-time experiences you have.)***

1 year	10%
2 to 5 years	18%
6 to 10 years	10%
11 or more years	63%

N = 166

3. **How many years have you spent teaching mathematics?** ***(Include the current year and round to the nearest year any part-time experiences you have.)***

	Elementary	*Secondary*
1 year	14%	12%
2 to 5 years	41%	30%
6 to 10 years	32%	16%
11 or more years	14%	43%
	N = 22	N = 164

4. **How many full-year courses in mathematics methods were included in your teacher education?**

No course in mathematics methods	22%
Some instruction as part of a general course	18%
One full course in mathematics methods	36%
Two or more full courses in mathematics methods	24%

N = 162

5. **How many full-year university courses do you have in mathematics?**

Zero	13%
One	9%
Two	12%
Three	11%
Four	4%
Five or more	50%

N = 166

6. **How many courses in measurement and evaluation or testing were included in your teacher training and/or graduate courses?**

Zero	27%
One	55%
Two	9%
Three or more	9%

N = 165

7. **Have you received training on the instructional use of computers with respect to the teaching of mathematics?**

Yes	28%
No	72%

N = 166

Section 2: TEACHING PRACTICES

8. What importance do you place on the instruction of the following topics?

	Not Important	*Important*	*Very Important*	
Number applications	1%	30%	70%	N = 165
Power and square roots	13%	70%	18%	N = 165
Applications of ratio, rate, and per cent	1%	33%	67%	N = 165
Statistics	23%	58%	20%	N = 164
Personal finance and banking	2%	25%	72%	N = 166
Borrowing and saving	2%	31%	67%	N = 165
Polynomials, formulas, and equations	7%	61%	32%	N = 164
Graphing	8%	67%	25%	N = 165
Linear equations	16%	65%	20%	N = 164
Geometric figures and properties	18%	65%	16%	N = 165
Problem solving	1%	28%	70%	N = 166

9. How much time per week outside of class do you think that the average student in your class will take to complete his/her mathematics homework assignments?

Less than 1 hour	46%	
1 to 2 hours	42%	
Between 2 and 3 hours	11%	
3 hours or more	1%	N = 166

10. Do your students of mathematics have access to computers?

Yes	30%	
No (Go to Question 13)	70%	N = 166

11. Approximately what percentage of time do your mathematics students spend using computers per week?

% of Time	*% of Teachers*			
0-4% of time	74%	Average		
5-9% of time	11%	percentage		
10-14% of time	13%	of time:	3%	
15-19% of time	0%			
20% or more	2%			N = 46

12. Do you encourage your mathematics students to use computers to do any of the following?

	Yes	*No*	
To check answers to exercises	17%	83%	N = 48
To practise new concepts	25%	75%	N = 48
To learn new concepts and skills	15%	85%	N = 46
To take tests	0%	100%	N = 45
As an aid to do projects	27%	73%	N = 48

13. In your mathematics classes how often are calculators used?

Often (during every or almost every class)	74%	
Occasionally (during about half the lessons)	21%	
Rarely	3%	N = 167
Never	2%	

14. Do you encourage your mathematics students to use calculators to do any of the following?

	Yes	*No*	
To check answers to exercises	93%	7%	N = 167
To practise new concepts	78%	22%	N = 164
To learn new concepts and skills	71%	29%	N = 163
For use during tests	95%	5%	N = 165
As an aid to do projects	88%	12%	N = 159

15. How much emphasis is placed on each of the following in preparing lessons in mathematics?

	Not Available	*None*	*Some*	*A Lot*	
Ministry of Education guideline	0%	4%	49%	47%	N = 165
Board materials	11%	17%	47%	25%	N = 165
Textbook or teacher's edition of textbook	2%	2%	31%	65%	N = 166
Materials prepared by yourself or other teachers in your school	0%	0%	37%	63%	N = 166
Journals or other teacher reference books	2%	28%	63%	7%	N = 163
Commercially produced supplementary materials	6%	28%	60%	5%	N = 165
Materials from teacher education courses	8%	55%	35%	2%	N = 166
Materials from your in-service workshops, conferences, and seminars	7%	35%	56%	3%	N = 167
Suggestions from students	4%	36%	59%	2%	N = 167

16. What percentage of time during the school year do you use each of the following methods or aids for the teaching of mathematics? *(The percentages should total 100%.)*

A chalkboard and/or projector presentation to the class

% of Time	*% of Teachers*			
0-24%	10%	Average		
25-49%	44%	percentage		
50-74%	31%	of time:	47%	
75% or more	15%			N = 167

Teacher demonstration with concrete materials to the class

% of Time	*% of Teachers*			
0-4%	10%	Average		
5-9%	27%	percentage		
10-19%	45%	of time:	10%	
20-29%	15%			
30% or more	3%			N = 152

Students working cooperatively in groups

% of Time	*% of Teachers*			
0-4%	9%	Average		
5-9%	17%	percentage		
10-19%	37%	of time:	16%	
20-29%	21%			
30% or more	16%			N = 163

Students working individually

% of Time	*% of Teachers*			
0-9%	5%	Average		
10-19%	13%	percentage		
20-29%	23%	of time:	34%	
30-39%	21%			
40% or more	38%			N = 165

Note: The sum of the four percentages specified by teachers was often greater than 100%. Therefore, the sum of the four averages may be greater than 100%.

17. Which of the following materials do you have access to during the teaching of mathematics?

	Yes	*No*	
Blackline masters (photocopy masters)	83%	17%	N = 165
Commercially produced audio-visual materials	47%	53%	N = 162
Dot paper/grid paper	96%	4%	N = 166
Geoboards	25%	75%	N = 158
Pattern blocks, geometric solids	56%	44%	N = 160
Geometry set	90%	10%	N = 163
Student-generated materials	35%	65%	N = 160
Textbooks	98%	2%	N = 166

18. How much emphasis do you place on each of the following in your mathematics class?

	None	*Some*	*A Lot*	
Blackline masters (photocopy masters)	16%	46%	39%	N = 166
Commercially produced audio-visual materials	58%	38%	4%	N = 162
Dot paper/grid paper	9%	72%	19%	N = 167
Geoboards	90%	10%	0%	N = 157
Pattern blocks and geometric solids	53%	47%	0%	N = 159
Geometry set	12%	80%	9%	N = 164
Student-generated materials	62%	33%	5%	N = 159
Textbooks	3%	14%	83%	N = 167

19. What percentage of time is devoted to the problem-solving process?

% of Time	*% of Teachers*			
0-19%	17%	Average		
20-29%	27%	percentage		
30-39%	22%	of time:	34%	
40-49%	7%			
50-59%	12%			
60% or more	15%			N = 162

20. Which of the following best describes the problem-solving component of your mathematics program?

I teach problem solving as a separate unit.	7%	
I integrate problem solving into the mathematics program throughout the year.	92%	
Both	1%	N = 167

21. What approaches do you use in teaching problem solving?

	Yes	*No*	
I provide students with many puzzles and problems to solve.	72%	28%	N = 156
I provide students with a systematic approach to solving problems (e.g. understand, plan, solve, look back).	93%	7%	N = 163
I teach specific strategies for solving problems (e.g. guess and check, make a list, draw diagram, etc.).	86%	14%	N = 161
I encourage students to develop their own strategies.	82%	18%	N = 160

22. How are the solutions to problems in mathematics dealt with by the students?

	Yes	*No*	
Students discuss their solutions with each other.	89%	11%	N = 160
Students report their results to the whole class.	67%	33%	N = 162
Students write up their solutions or the results of their discoveries and present them to the teacher.	86%	14%	N = 160

23. Do you use diagnostic pre-tests in your mathematics class?

Never	28%	
Sometimes	67%	
Often	5%	N = 167

24. On average, how often do you assess your students' learning of mathematics skills and concepts?

Less than once per month	0%
Once per month	1%
Twice per month	16%
Three times per month	19%
Four times per month or more	64%

N = 167

25. In mathematics, what per cent of the students' final mark is determined through the use of the following? *(The total for the grade should add up to 100%.)*

	Percentage of Mark	*Percentage of Teachers*	*Average Percentage of Mark*	
Quizzes or short tests	0-9%	7%	19%	
	10-19%	46%		
	20-29%	27%		
	30-39%	11%		
	40% or more	10%		N = 165
Cumulative tests or end-of-unit tests	0-19%	5%	34%	
	20-29%	29%		
	30-39%	27%		
	40-49%	25%		
	50-59%	8%		
	60% or more	6%		N = 163
Formal examinations	0-19%	5%	28%	
	20-29%	38%		
	30-39%	38%		
	40-49%	16%		
	50% or more	3%		N = 165
Observation of student behaviour	0%	10%	11%	
	1-9%	17%		
	10-14%	43%		
	15-24%	26%		
	25% or more	4%		N = 146
Peer/self-evaluation	0%	73%	3%	
	1-4%	1%		
	5-9%	16%		
	10% or more	10%		N = 108
Others (projects, assignments, etc.)	0%	8%	11%	
	1-9%	23%		
	10-14%	44%		
	15-24%	17%		
	25% or more	8%		N = 143

Appendix C: Student Questionnaire

The percentage of students selecting each response is given for each question. The percentage of students omitting each question is also given. The percentages are based on the total number of students responding to the questionnaire in the province (4181).

1. Are you male or female?

56%	A) Male.
44%	B) Female.
0%	(omit)

2. In which year were you born?

15%	A) 1972 or before.
30%	B) 1973.
54%	C) 1974.
1%	D) 1975.
0%	E) 1976 or after.
0%	(omit)

3. What language do you most often speak at home?

93%	A) English.
1%	B) French.
6%	C) Other.
0%	(omit)

4. On average how much time out of school do you spend watching TV programs each day?

4%	A) None at all.
19%	B) Up to 1 hour.
33%	C) Between 1 and 2 hours.
26%	D) Between 2 and 3 hours.
18%	E) More than 3 hours.
0%	(omit)

5. About how much time do you spend on mathematics homework each week?

43%	A) I don't do any mathematics homework.
41%	B) Less than 1 hour.
14%	C) One to 2 hours.
2%	D) More than 2 hours.
0%	(omit)

6. How often do you get help with mathematics from someone in your family?

58%	A) Never or almost never.
39%	B) Occasionally.
3%	C) Often.
0%	(omit)

7. Which of the following describes how the mathematics program in your school is organized?

43%	A) Full-year.
56%	B) Semestered.
2%	C) Other.
0%	(omit)

DO YOU LIKE DOING MATHEMATICS QUESTIONS THAT DEAL WITH:

8. Number Applications?

52%	A) Yes.
22%	B) No.
25%	C) I'm not sure.
1%	D) We don't do these kinds of questions.
0%	(omit)

9. Powers and Square Roots?

60%	A) Yes.
32%	B) No.
8%	C) I'm not sure.
0%	D) We don't do these kinds of questions.
0%	(omit)

10. Applications of Ratio, Rate, and Per Cent?

50%	A) Yes.
40%	B) No.
9%	C) I'm not sure.
0%	D) We don't do these kinds of questions.
0%	(omit)

11. Statistics?

39%	A) Yes.
34%	B) No.
21%	C) I'm not sure.
5%	D) We don't do these kinds of questions.
0%	(omit)

12. Budgeting and Personal Banking?

43%	A) Yes.
31%	B) No.
14%	C) I'm not sure.
11%	D) We don't do these kinds of questions.
0%	(omit)

13. Interest Rate?

41%	A) Yes.
39%	B) No.
14%	C) I'm not sure.
6%	D) We don't do these kinds of questions.
0%	(omit)

14. Polynomials, Formulas, and Solving Equations?

37%	A) Yes.
51%	B) No.
11%	C) I'm not sure.
1%	D) We don't do these kinds of questions.
0%	(omit)

DO YOU LIKE DOING MATHEMATICS QUESTIONS THAT DEAL WITH:

15. Drawing Graphs from Tables?

65%	A) Yes.
26%	B) No.
7%	C) I'm not sure.
2%	D) We do not do these kinds of questions.
0%	(omit)

16. Graphs of Linear Equations?

36%	A) Yes.
40%	B) No.
18%	C) I'm not sure.
6%	D) We do not do these kinds of questions.
0%	(omit)

17. Geometric Figures and Properties?

28%	A) Yes.
47%	B) No.
18%	C) I'm not sure.
7%	D) We do not do these kinds of questions.
0%	(omit)

18. Problem Solving?

51%	A) Yes.
40%	B) No.
9%	C) I'm not sure.
0%	D) We do not do these kinds of questions.
0%	(omit)

The following questions ask about what you and your class do when you are learning mathematics. Think about what happens in your mathematics class.

19. How often do you do mathematics at the board or on the overhead projector?

42%	A) Almost every day.
13%	B) Once a week or so.
26%	C) Only once in a while.
18%	D) Never.
0%	(omit)

20. How often is mathematics presented to the whole class as a group?

87%	A) Almost every day.
4%	B) Once a week or so.
5%	C) Only once in a while.
4%	D) Never.
0%	(omit)

21. How often do you do mathematics in small groups?

10%	A) Almost every day.
8%	B) Once a week or so.
35%	C) Only once in a while.
47%	D) Never.
0%	(omit)

22. How often do you do mathematics on your own in class?

81%	A) Almost every day.
7%	B) Once a week or so.
8%	C) Only once in a while.
4%	D) Never.
0%	(omit)

23. How often do you do projects on mathematics topics?

2%	A) Almost every day.
4%	B) Once a week or so.
34%	C) Only once in a while.
59%	D) Never.
0%	(omit)

24. How often do you do projects in other subjects that involve the use of mathematics?

6%	A) Almost every day.
10%	B) Once a week or so.
55%	C) Only once in a while.
28%	D) Never.
0%	(omit)

25. How often do you write tests or quizzes in mathematics?

12%	A) Almost every day.
65%	B) Once a week or so.
22%	C) Only once in a while.
1%	D) Never.
0%	(omit)

26. How often do you use a calculator to do mathematics in class?

64%	A) Almost every day.
13%	B) Once a week or so.
18%	C) Only once in a while.
5%	D) Never.
0%	(omit)

27. How often do you use a computer to do mathematics in class?

1%	A) Almost every day.
1%	B) Once a week or so.
6%	C) Only once in a while.
92%	D) Never.
0%	(omit)

28. Do you use a calculator at home?

28%	A) No.
72%	B) Yes.
0%	(omit)

29. Do you have a computer at home?

61%	A) No.
14%	B) Yes, but I don't use it.
19%	C) Yes, I use it but not for mathematics schoolwork.
0%	D) Yes, I use it for mathematics schoolwork only.
4%	E) Yes, I use it for mathematics schoolwork and other things.
0%	(omit)

The following questions ask how you feel about the mathematics you are learning in school.

30. Do you think mathematics is:

3%	A) more for males than females?
3%	B) more for females than males?
94%	C) for everyone equally?
0%	(omit)

31. I like mathematics.

10%	A) Strongly agree.
38%	B) Agree.
22%	C) Not sure.
18%	D) Disagree.
12%	E) Strongly disagree.
1%	(omit)

32. Mathematics helps me outside of school.

23%	A) Strongly agree.
52%	B) Agree.
12%	C) Not sure.
9%	D) Disagree.
4%	E) Strongly disagree.
0%	(omit)

33. Learning mathematics is mostly memorizing.

17%	A) Strongly agree.
41%	B) Agree.
19%	C) Not sure.
19%	D) Disagree.
4%	E) Strongly disagree.
0%	(omit)

34. I am good at mathematics.

9%	A) Strongly agree.
40%	B) Agree.
26%	C) Not sure.
17%	D) Disagree.
8%	E) Strongly disagree.
0%	(omit)

35. It is important to know mathematics in order to get a good job.

46%	A) Strongly agree.
36%	B) Agree.
9%	C) Not sure.
6%	D) Disagree.
2%	E) Strongly disagree.
0%	(omit)

36. Mathematics is difficult for me.

11%	A) Strongly agree.
22%	B) Agree.
21%	C) Not sure.
35%	D) Disagree.
11%	E) Strongly disagree.
0%	(omit)

37. When I do problems in mathematics, I usually have trouble understanding what the sentences say.

7%	A) Strongly agree.
20%	B) Agree.
20%	C) Not sure.
42%	D) Disagree.
11%	E) Strongly disagree.
0%	(omit)

38. There are usually <u>different</u> ways to solve mathematical problems.

21%	A) Strongly agree.
61%	B) Agree.
14%	C) Not sure.
3%	D) Disagree.
1%	E) Strongly disagree.
0%	(omit)

WHEN YOU DON'T UNDERSTAND A PROBLEM IN MATHEMATICS DO YOU:

39. Try different ways to solve it on your own?

30%	A) Often.
62%	B) Sometimes.
8%	C) Never.
0%	(omit)

40. Ask another student for help?

28%	A) Often.
62%	B) Sometimes.
10%	C) Never.
0%	(omit)

41. Ask your teacher for help?

29%	A) Often.
61%	B) Sometimes.
9%	C) Never.
0%	(omit)

42. Wait and ask someone at home?

4%	A) Often.
28%	B) Sometimes.
68%	C) Never.
0%	(omit)

43. Just give up?

9%	A) Often.
52%	B) Sometimes.
39%	C) Never.
1%	(omit)

Appendix D: Mathematics Achievement

The results for all achievement items for Grade 10 (general level) mathematics are presented in this appendix.

1. Item Statistics for Student Assessment Booklets (D-1 to D-11).

Each table contains the results for the set of items dealing with one of the eleven topics, six in numerical methods, three in algebra, one in geometry, and the category of process problems. Within each table, the items are grouped according to level of complexity (recognition/recall, comprehension, and application). The items are identified by booklet number and item number. The set of questions for each topic precedes each table.

For multiple-choice questions, the key identifies the correct response, and the percentage of students selecting each response is given under columns *A*, *B*, *C*, and *D*. The percentage of students omitting each item is given under *O*. *OTL* represents the percentage of teachers who said that they taught the content covered by the question or that they felt it was taught in a previous year. *Cor* is the average percentage correct achieved by students. Some questions required students to write a response in the booklet, and most of these were marked correct or incorrect. A more detailed scoring scheme was used for some of the open-ended questions. The categories used in these scoring schemes and the algorithm for determining a correct response are outlined in Table D-13. For questions with two parts in the scoring guide, an answer had to meet the criteria for both parts in order to be rated as a correct response. For open-ended questions, data are provided only for *O*, *OTL*, and *Cor*.

For multiple-choice questions, the percentages are based on the total number of students answering each booklet. For the province, the numbers of students are as follows:

Booklet number:	1	2	3	4
Number of females:	453	436	423	420
Number of males:	522	521	518	516
Total number of students:	994	971	958	953

The total number is not equal to the sum of the numbers of females and males because some students did not specify gender.

For open-ended questions, a number of teachers did not record marks on the student answer sheets. The percentages reported for the item statistics are based on the total number of students for whom marks were recorded. This number of students is given below each table that contains data for open-ended questions. No data are reported for questions for which marks were recorded for fewer than 20 per cent of students who should have answered a given question. The number recorded under the *O* column is the percentage of students for whom teachers marked the no-response category. In Table D-11, the number of marked responses *(N)* is given for each question.

The conclusions of the interpretation panel are also provided. The acceptable level *(Acc)*, the desirable level *(Des)*, and the rating *(Rtg)* are given for each question. These terms have been discussed in "3.3 Interpretation of Results".

2. Strategies for Process Problems (D-12)

This table gives the percentage of students who used each strategy in obtaining solutions to process problems.

3. Scoring Criteria for Selected Open-Ended Questions (D-13)

The percentage of students in each category of the scoring guide is given for each question. The algorithm for determining a correct response is also given.

4. No-Calculator Questions (D-14)

The average percentage correct *(Cor)* and the percentage of students omitting each question *(O)* are given in addition to the percentage of students selecting each response.

5. Summary of Achievement by Topic (D-15)

This table presents a summary of the data for groups of questions by topic. Averages are provided for percentage correct and opportunity to learn. Average percentage correct is given for males, females, and the total student population.

Panel ratings are given for each content area. The reported acceptable *(Acc)* and desirable *(Des)* levels were obtained by averaging the levels assigned to each question. The rating *(Rtg)* was assigned to each topic through deliberations of the panel. Panel ratings are not provided for the cognitive levels.

6. Opportunity to Learn (D-16)

Teachers were asked whether or not they had taught the content required to answer each question in the Student Assessment Booklets. Results for each question are presented in Table D-16. The percentage of teachers who said that they taught the content is reported in the column *Taught*, and the percentage of teachers who said that the content was not taught is reported in four columns according to the reason for not teaching it (assumed taught in a prior year, intended to teach it later in the year, content not in the curriculum, and other reasons).

STUDENT ASSESSMENT BOOKLETS

MATHEMATICS

Grade 10 Mathematics, General Level

PROVINCIAL REVIEWS

Program Implementation & Review Branch
Ministry of Education

41. Don and Yuri took a taxi back from a show. The following table compares distance (**d**) in kilometres and cost (**c**) in dollars.

d (km)	1	2	3	4	5	6	7
c ($)	1.30	1.50	1.70	1.90	2.10	2.30	2.50

The cost for a trip of 9 km would be:

A) $2.50
B) $2.70
C) $2.90
D) $3.10

1. A monthly magazine costs $3.95 at the news-stand. You can buy an annual subscription (12 issues) for $33.00. If you intend to buy the next 12 issues, the amount you would save by buying the subscription is:

A) $14.40
B) $29.05
C) $47.40
D) $80.40

2. Clarke and Sabrina took a taxi back from the formal. The following table compares the distance (**d**) in kilometres and cost (**c**) in dollars.

d (km)	1	2	3	4	5	6	7
c ($)	$1.30	$1.50	$1.70	$1.90	$2.10		$2.50

The cost for a trip of 6 km is:

A) $2.20
B) $2.30
C) $2.40
D) $3.40

PLACE YOUR ANSWER IN THE SPACE PROVIDED

69. The formula for the volume (V) of a rectangular room is **V = LWH** where length (L), width (W), and height (H) are the room's dimensions.

To determine which air conditioner to buy, Bill needed to know the volume of his room. Its length is 4.0 m, its width is 3.0 m, and its height is 2.4 m. Calculate its volume to the nearest cubic metre.

Answer: _____ m^3

81. Renata received marks of 13, 16, 15, 16, 14, and 15 on six tests worth 20 marks each. Renata's average mark to one decimal place is:

A) 4.5
B) 14.8
C) 15.8
D) 89.0

82. The temperature at noon was 13°C. By midnight, it had fallen 19 degrees. The temperature at midnight is:

A) -32°C
B) -6°C
C) +6°C
D) +32°C

110. Complete the following bank statement by filling in the unshaded boxes to show the balances for May 5 and May 15.

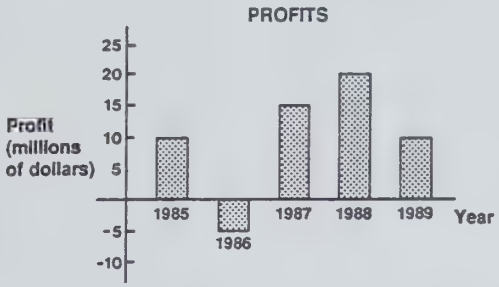
BANK STATEMENT

Date	Withdrawal	Deposit	Balance
May 1			732.04
May 5	14.52		
May 5		100.00	
May 10		55.00	872.52
May 15	37.68		
May 15	29.37		

121. Tom's hockey team finished the season with 17 wins, 5 ties, and 12 losses. A win counts 2 points, a tie 1 point, and a loss 0 points. The number of points the team has is:

A) 5
B) 22
C) 34
D) 39

122. The graph below shows the profits for a large corporation for the last 5 years.



The total profit for the 5-year period, in millions of dollars, is:

A) 10
B) 20
C) 50
D) 60

123. The table shows the cost of making a long-distance telephone call from Toronto to Thunder Bay on Saturday morning.

Time (min)	2	4	6	8	10
Cost ($)	1.40	2.60	3.80	5.00	6.20

The cost of a 5-minute call would be:

A) $3.10
B) $3.20
C) $3.30
D) $3.50

Table D-1
Numerical Methods: Applications of Numbers

										Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Comprehension	2-41	(C)	1	7	84	7		1	95	84	70	85	4
Application	1-1	(A)	77	7	14	1		0	98	77	70	90	3
	1-2	(B)	2	95	2	1		0	95	95	75	85	4
	2-69*							14	91	18	65	80	1
	3-81	(B)	7	58	11	22		2	83	58	70	85	2
	3-82	(B)	1	95	3	1		0	99	95	75	90	5
	3-110*							17	72	68	60	90	3
	4-121	(D)	1	3	5	90		0	99	90	70	90	4
	4-122	(C)	13	9	74	4		1	76	74	60	80	4
	4-123	(B)	13	62	16	8		1	90	62	55	75	3

*Number of students for question 2-69 is 959 and for question 3-110 is 951.

Powers and Square Roots

3. The expression 5^3 means:

A) 5×3
B) $5 + 5 + 5$
C) $5 \times 5 \times 5$
D) $3 \times 3 \times 3 \times 3 \times 3$

43. The positive square root of 16 is:

A) 256
B) 32
C) 8
D) 4

4. The expression $(3^2)^5$ equals:

A) 3^{10}
B) 3^7
C) 6^5
D) 15^{10}

29. State the positive square root of 12.59 correct to two decimal places.

Answer: _____

42. The number 0.000 081 written in scientific notation is:

A) 0.81×10^{-5}
B) 0.81×10^{-4}
C) 8.1×10^{-4}
D) 8.1×10^{-5}

44. The radius (r) of a circle is given by the formula

$r = \sqrt{\frac{A}{3.14}}$, where A represents the area of the circle.

If the area of a circle is 85 cm^2, then the radius is:

A) 0.19 cm
B) 2.9 cm
C) 5.2 cm
D) 27 cm

83. The value of 3^{-2} is:

A) $\frac{1}{9}$
B) $-\frac{1}{9}$
C) -6
D) -9

84. The expression $3^6 + 3^2$ equals:

A) 3^3
B) 1^3
C) 3^4
D) 3^8

124. The value of $(-2)^4$ is:

A) -16
B) -8
C) 8
D) 16

125. The expression $4^2 \times 4^3$ equals:

A) 4^5
B) 4^6
C) 8^5
D) 16^5

Table D-2
Numerical Methods: Powers and Square Roots

Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Panel Rating* *Acc*	*Des*	*Rtg*
Recognition/Recall	1-3	(C)	1	4	96	0		0	100	96	80	90	4
	2-43	(D)	10	2	5	83		0	99	83	75	90	3
Comprehension	1-4	(A)	41	37	14	7		1	98	41	60	75	1
	1-29*							15	98	49	80	90	1
	2-42	(D)	13	33	5	48		0	95	48	60	75	2
	2-44	(C)	5	12	35	46		2	94	35	60	75	1
	3-83	(A)	21	7	21	50		1	92	21	50	65	1
	3-84	(C)	8	13	62	17		0	99	62	60	75	3
	4-124	(D)	19	10	4	67		0	99	67	55	70	3
	4-125	(A)	60	6	6	28		0	99	60	65	85	3

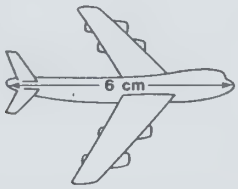
*Number of students for question 1-29 is 986.

7. At a school dance, the ratio of the number of girls to the number of boys is 3:2.

Which one of the following statements is true?

A) There are 3 times as many girls as boys.
B) There are 3 boys for every 2 girls.
C) There are 3 girls for every 2 boys.
D) The number of girls is one more than the number of boys.

5. This is a scale drawing of a jumbo jet.



Scale: 1 cm represents 12 m

The actual length of the jet, in metres, is:

A) 6
B) 12
C) 50
D) 72

6. A record album that sells for $11.00 at the regular price is on sale for $8.80. The percentage discount off the regular price is:

A) 80%
B) 25%
C) 22%
D) 20%

45. A sum of $60 is shared between two people. If the ratio of Gaston's share to Elise's share is 2:3, Gaston's share is:

A) $20
B) $24
C) $36
D) $40

47. Jill works at The Roasted Chicken and has an hourly wage of $4.80. After three months, her hourly wage will be increased by 5%. Her new hourly wage will be:

A) $0.24
B) $5.04
C) $5.52
D) $7.20

85. A painter is to mix green and yellow paint in the ratio of 4 to 7 to obtain the colour he wants. If he has 28 L of green paint, how many litres of yellow paint should be added?

A) 16
B) 28
C) 49
D) 196

86. In a survey of 120 Grade 9 students, 90 replied that they talked on the telephone at least once a day. What per cent of those surveyed talked on the telephone at least once a day?

A) 25%
B) 30%
C) 75%
D) 90%

111. To make a fruit punch, you mix two cans of apple juice, three cans of grape juice, and four cans of ginger ale. The cans are all the same size. What is the ratio of the amount of apple juice, to the amount of grape juice, to the amount of ginger ale?

Answer: _____

126. A 100-mL tube of toothpaste sells for $1.75. The price per millilitre is:

A) $175.00
B) $57.14
C) $0.57
D) $0.0175

127. In a school of 800 pupils, 300 are boys. The ratio of the number of boys to the number of girls is:

A) 3:8
B) 3:11
C) 3:5
D) 5:3

128. A pair of skis sells for the regular price of $395.00. At 30% off, the sale price is:

A) $118.50
B) $276.50
C) $365.00
D) $513.50

Table D-3
Numericals Methods: Applications of Ratio, Rate, and Per Cent

										Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Comprehension	1-7	(C)	4	6	67	23		0	87	67	70	80	2
Application	1-5	(D)	2	3	2	93		0	80	93	75	90	4
	1-6	(D)	17	13	35	35		1	96	35	60	75	1
	2-45	(B)	37	33	11	18		1	81	33	50	70	1
	2-47	(B)	21	68	5	5		1	95	68	65	80	3
	3-85	(C)	20	10	62	7		1	85	62	65	80	3
	3-86	(C)	3	8	82	7		0	96	82	70	85	4
	3-111*							13	88	77	70	90	3
	4-126	(D)	8	7	11	74		0	96	74	65	85	3
	4-127	(C)	23	2	68	7		0	86	68	60	80	3
	4-128	(B)	29	55	14	1		0	98	55	65	85	2

*Number of students for question 3-111 is 937.

9. Nine students ran a 100-m race. Their times in seconds were:

15, 10, 12, 17, 17, 15, 13, 12, 15

The mode is:

A) 17
B) 15
C) 14
D) 10

49. "One-half of the workers earned $25 000 or more last year."

In this statement, $25 000 represents:

A) the mean.
B) the median.
C) the mode.
D) the range.

88. Seven students wrote a mathematics test marked out of 100. Their marks were:

71, 72, 72, 79, 87, 90, 96

The median is:

A) 72
B) 79
C) 81
D) 85

130. Seven students wrote a mathematics test marked out of 100. Their marks were:

87, 79, 71, 72, 72, 90, 96

The mean is:

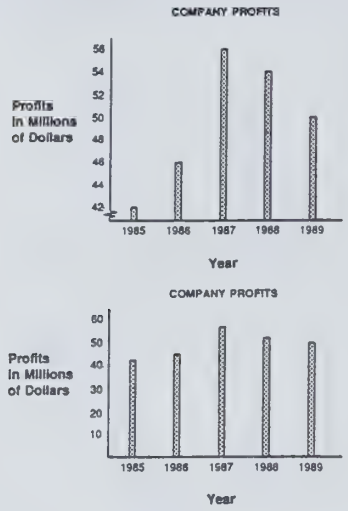
A) 72
B) 79
C) 81
D) 85

8. Pat is running for the office of school president. Pat plans to conduct a survey to ask students whom they are planning to vote for in the upcoming election.

The most appropriate method of conducting the poll is to:

A) ask 12 people in her homeroom.
B) ask all students in Grade 12.
C) ask every tenth student on the school list.
D) ask her friends.

46. The two graphs below show the same data.



Why do the two graphs above give different impressions?

A) The scale on the profits axis has been changed.
B) The scale on the year axis has been changed.
C) The scales on both axes have been changed.
D) The graphs represent different information.

48. 70 out of 100 students surveyed planned to vote for Liz for president. How many of the 1 000 students in the school may be expected to vote for Liz?

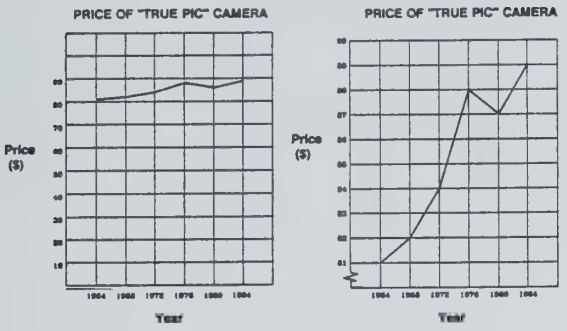
A) 700
B) 170
C) 100
D) 70

87. You need to select a representative sample of students in your high school to decide whether or not you should raise the student activity fee by $5.00.

Which of the following samples is the least biased?

A) Every Grade 10 student in the school.
B) Every member of all sports teams of the school.
C) Every female student in the school.
D) Every 5th student from the school list.

89. The two graphs below show the same data.



Why do the two graphs above give different impressions?

A) The scales on both axes have been changed.
B) The scale on the year axis has been changed.
C) The scale on the price axis has been changed.
D) The graphs represent different information.

129. You are asked to gather data to determine whether or not a library should be built in your community. You plan to conduct a survey.

The best population from which to choose the sample would be:

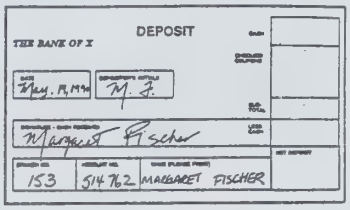
A) all the people living in the community.
B) all the members of book clubs in the community.
C) all the students in your school.
D) all the teachers in your school.

Table D-4
Numerical Methods: Statistics

											Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Comprehension	1-9	(B)	24	50	22	3		1	64	50	50	60	3
	2-49	(B)	20	39	18	22		1	64	39	50	50	3
	3-88	(B)	13	49	35	3		1	65	49	65	85	3
	4-130	(C)	29	12	56	2		1	66	56	70	90	3
Application	1-8	(C)	6	18	71	5		0	57	71	60	80	3
	2-46	(A)	80	4	9	6		1	66	80	65	80	4
	2-48	(A)	90	4	1	4		0	90	90	70	85	4
	3-87	(D)	10	21	7	62		1	55	62	60	80	3
	3-89	(C)	10	4	81	5		0	67	81	65	80	4
	4-129	(A)	87	7	5	0		0	58	87	60	80	4

152. Margaret Fischer gets her pay cheque today. Margaret deposits her cheque for $125 less $50 she wishes to keep as cash.

Complete the deposit slip for Margaret.



10. Jennifer's bank charges $0.35 for each cheque she writes on her chequing account. However, there is no charge for withdrawals or deposits.

DATE M D	DESCRIPTION	DEBITS	CREDITS	BALANCE
05 04	Balance forward			315.84
05 08	Cheque # 135	75.49		249.35
05 10	Withdrawal	50.00		190.35
05 15	Deposit		529.07	
05 15	Withdrawal	200.00		519.42
05 24	Cheque # 138	42.32		477.10
05 30	Cheque # 136	69.55		407.55
05 31	Service Charge			

The service charge should be:

A) $0.35
B) $1.05
C) $1.75
D) $2.10

50. Olav keeps a record of all his banking.

Date	Description	Debit	Credit	Balance
May 1	Carried forward			178.43
May 5	Cheque #121	19.86		158.57
May 10	Withdrawal	40.00		
May 15	Pay		72.10	

The balance on May 15 is:

A) $270.67
B) $190.67
C) $126.47
D) $46.47

90. Llarian had $250 take-home pay from her part-time job during the last month. She used part of the money as shown in the following chart.

CATEGORY	AMOUNT
Savings	$41.35
Transportation	$57.80
Food	$65.10
Entertainment	?

The amount Llarian could spend on entertainment is:

A) $85.75
B) $164.25
C) $168.45
D) $208.65

91. Your bank statement shows a balance of $275.16. A cheque for $20 and a cheque for $10 do not appear on the statement because they are outstanding cheques.

The balance that should appear in your own records is:

A) $245.16
B) $285.16
C) $295.16
D) $305.16

131. Your bank statement shows a balance of $374.75. There is one outstanding cheque (one that doesn't appear on the statement) for $80.00 for the purchase of a jacket.

What balance should appear in your own records?

A) $80.00
B) $294.75
C) $374.75
D) $454.75

Table D-5
Numerical Methods: Personal Finance and Banking

											Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Comprehension	4-152*							18	63	36	65	95	2
Application	1-10	(B)	11	76	9	4		1	70	76	75	90	3
	2-50	(B)	6	71	15	8		1	70	71	75	90	3
	3-90	(A)	92	6	1	1		0	92	92	70	90	4
	3-91	(A)	55	2	3	39		0	70	55	65	90	3
	4-131	(B)	2	72	9	17		0	69	72	75	90	3

*Number of students for question 4-152 is 944.

52. Which one of the following is a type of savings?

A) Demand Loan
B) Charge Account
C) Line of Credit
D) Guaranteed Investment Certificate

133. Which one of the following is a type of borrowing available to the consumer?

A) Personal Loan
B) Canada Savings Bonds
C) Guaranteed Investment Certificate
D) Daily Interest Savings Account

11. Which of the following is a type of credit buying?

A) Depositing money in a bank account.
B) Paying for a pair of shoes with cash.
C) Paying for tickets for a concert with a cheque.
D) Paying for clothes with a credit card.

12. Jan borrowed $648 to buy a Mountain Bike. The bank charged $120 in interest. The total amount is paid off in one year. The monthly payment is:

A) $10
B) $44
C) $54
D) $64

13. Todd has an outstanding balance of $350 on his credit card account. The interest charge is 2% per month. The amount of interest that will be charged for one month is:

A) $0.58
B) $7.00
C) $84.00
D) $357.00

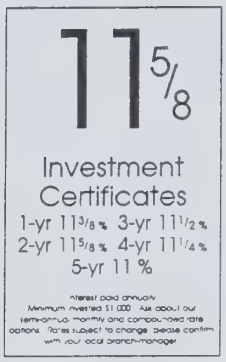
51. Kris borrowed $600 for 4 months at 24%/a. The formula to calculate simple interest on such a loan is:

$$I = prt$$

The simple interest is:

A) $48
B) $144
C) $192
D) $576

53. The advertisement below shows that a 3-yr Investment Certificate earns $11\frac{1}{2}$ % simple interest paid annually.



The interest earned for the first year on a 3-yr Investment Certificate of $1 000 is:

A) $1.15
B) $11.50
C) $115.00
D) $1115.00

92. $1 000 is invested at 10%/a compounded annually.

	Principal at the beginning of the year	Interest for the year	Amount at the end of the year
1st year	$1 000	$100	$1 100
2nd year	$1 100		

The interest for the second year is:

A) $100
B) $110
C) $210
D) $1 210

93. Jodie buys a stereo that sells for $599, including tax. She has a choice of paying cash or $55 per month for 12 months on the instalment plan. She chooses the instalment plan.

How much more does she have to pay since she has chosen not to pay cash?

A) $5.08
B) $49.92
C) $61.00
D) $660.00

Borrowing and Saving (cont'd)

132. $1 000 is invested at 10%/a compounded annually.

	Principal at the beginning of the year	Interest for the year	Amount at the end of the year
1st year	$1 000	$100	$1 100
2nd year			

The principal at the beginning of the second year is:

A) $100
B) $1 000
C) $1 100
D) $2 100

Table D-6
Numerical Methods: Borrowing and Saving

										Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Recognition/Recall	2-52	(D)	2	15	18	64		1	52	64	65	85	3
	4-133	(A)	89	3	3	5		0	59	89	70	85	4
Comprehension	1-11	(D)	7	2	4	86		0	69	86	80	90	3
Application	1-12	(D)	19	5	17	58		1	77	58	70	85	2
	1-13	(B)	10	82	4	4		1	83	82	65	80	4
	2-51	(A)	33	29	10	27		1	82	33	60	75	1
	2-53	(C)	4	16	68	10		2	74	68	50	65	4
	3-92	(B)	11	60	13	16		1	68	60	65	85	3
	3-93	(C)	3	7	63	27		1	79	63	65	85	3
	4-132	(C)	8	8	68	15		1	67	68	65	90	3

14. The table below shows the relationship between the cost (c) and the number *(n)* of student cards.

n	c
1	5
2	10
3	15
4	20

The formula that relates the cost (c) and the number *(n)* of student cards is:

A) $c = 5n$
B) $c = n$
C) $c = 4n$
D) $c = \frac{n}{5}$

16. The expression (2x) (–3y) is equal to:

A) –xy
B) –5xy
C) –6xy
D) $-x^2y^3$

17. **E = IR** is an important formula in electricity.

E represents the voltage in volts.
I represents the current in amperes.
R represents the resistance in ohms.

If **E** is 600 volts and **R** is 400 ohms, the current **I** is:

A) 1 000 amperes
B) 200 amperes
C) 1.5 amperes
D) 0.7 amperes

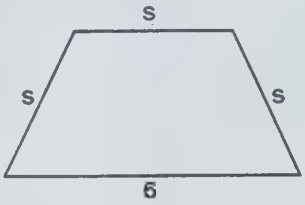
32. Solve for **n** using an algebraic solution.

$$2n - 2 = -9n + 20$$

54. The expression (+3z) – (–z) equals:

A) 4z
B) 2z
C) $3z^2$
D) $4z^2$

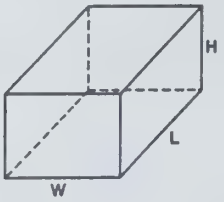
55. Examine the figure below:



Which formula represents the perimeter of this figure?

A) p = 6s
B) p = s + 6
C) p = 3s + 6
D) p = 2(6 + s)

56. **V = LWH** is a formula for the volume (V) of a rectangular solid.



If **V** = 100, **L** = 8.0, and **W** = 5.0, then **H** is:

A) 0.4
B) 2.5
C) 60
D) 4 000

57. A first step in solving the equation 5x – 2 = 13 is to add a number to both sides of the equation. The best number to add to both sides is:

A) 5
B) 2
C) –2
D) 13

58. The expression 2(a + 3) + 3(a + 4) equals:

A) 18a
B) 6a + 10
C) 5a + 7
D) 5a + 18

95. The expression $(2r + 3p) + (6r - 8p)$ equals:

A) $8r - 5p$
B) $12r - 24p$
C) $3rp$
D) $8r - 11p$

96. The expression $(2m)(3n)$ equals:

A) $5mn$
B) $2m + 3n$
C) $6mn$
D) m^2n^3

97. The expression $3(5x - 2y + 3)$ equals:

A) $15x - 2y + 3$
B) $15x - 6y + 9$
C) $-90xy$
D) $18xy$

98. To solve the equation $\frac{1}{3}a = 6$:

A) multiply both sides by 3 to get $a = 18$.

B) multiply the left side by 3 to get $a = 6$.

C) divide both sides by 3 to get $a = 2$.

D) divide the left side by $\frac{1}{3}$ to get $a = 6$.

134. $2x + x + 8 + 4 =$

A) $2x + 12$
B) $3x + 12$
C) $14x$
D) $15x$

135. $(2a + 3b) - (5a - 2b) =$

A) $3a + b$
B) $-3a + b$
C) $3a + 5b$
D) $-3a + 5b$

136. $-5a\,(3b - 2) =$

A) $-15ab + 10a$
B) $-15ab - 10a$
C) $-15ab + 2$
D) $-15ab - 2$

137. $(-5a)(-5a) =$

A) $-25a^2$
B) $-10a^2$
C) $10a^2$
D) $25a^2$

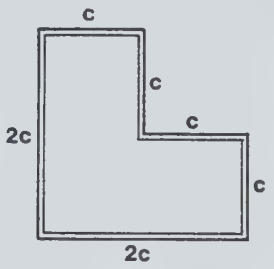
138. $P = 2L + 2W$ is the formula for the perimeter (P) of a rectangle with length (L) and width (W). If $P = 34$ and $W = 7$, then L is:

A) 10
B) 18
C) 20
D) 24

151. Solve for x using an algebraic solution.

$$7x - 4 = 2x + 41$$

15. A ceiling moulding is installed in the L-shaped room pictured below.



An expression for the total length of ceiling moulding is:

A) $8c$
B) $6c$
C) $5c$
D) $4c$

18. A marathon cyclist travels around a route four times. The total distance travelled is 461.76 km. Let the distance of one lap around the route be **d** km.

The equation that could be used to determine **d** is:

A) $\mathbf{d} + 461.76 = 4\mathbf{d}$
B) $2\mathbf{d} = 461.76$
C) $\mathbf{d} = 4 \times 461.76$
D) $4\mathbf{d} = 461.76$

94. Nigel works in a packaging factory in the summer. He earns \$32 per day and a bonus of \$2 for each of N orders that he packages.

The formula that describes Nigel's total daily pay (P), in dollars, is:

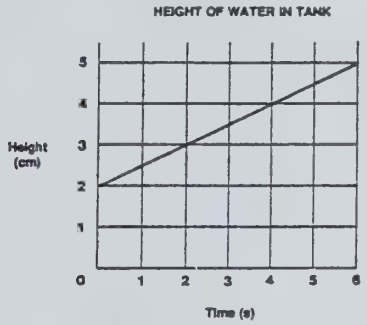
A) $P = (32 + N)2$
B) $P = (32 + 2)N$
C) $P = 32N + 2$
D) $P = 32 + 2N$

Table D-7
Algebra: Polynomials, Formulas, and Equations

											Panel Rating	
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Comprehension	1-14	(A)	46	20	16	17		1	77	46	60	65	2
	1-16	(C)	9	10	77	4		0	98	77	70	80	3
	1-17	(C)	21	37	39	2		1	90	39	55	80	1
	1-32*							24	99	46	60	75	2
	2-54	(A)	51	18	22	9		0	98	51	65	75	2
	2-55	(C)	7	6	78	8		1	93	78	70	85	3
	2-56	(B)	13	51	16	19		1	88	51	55	80	2
	2-57	(B)	17	51	23	8		2	95	51	70	90	2
	2-58	(D)	15	6	29	49		1	98	49	65	80	1
	3-95	(A)	62	11	8	18		0	98	62	65	75	3
	3-96	(C)	16	11	68	4		1	98	68	70	85	3
	3-97	(B)	13	76	3	7		1	98	76	70	85	3
	3-98	(A)	32	18	27	22		2	98	32	65	80	1
	4-134	(B)	7	84	5	4		0	98	84	70	90	3
	4-135	(D)	13	45	14	27		1	98	27	55	70	1
	4-136	(A)	50	14	9	25		1	98	50	55	75	2
	4-137	(D)	10	4	8	77		1	98	77	60	75	4
	4-138	(A)	39	17	33	9		2	93	39	55	80	2
	4-151*							25	98	47	60	75	2
Application	1-15	(A)	73	9	2	15		1	95	73	70	85	3
	1-18	(D)	7	5	29	58		1	81	58	50	50	3
	3-94	(D)	11	16	6	66		1	75	66	50	50	4

*Number of students for question 1-32 is 987 and for question 4-151 is 940.

19. A tank is being filled with water. The graph below shows the height of water in the tank for different times.



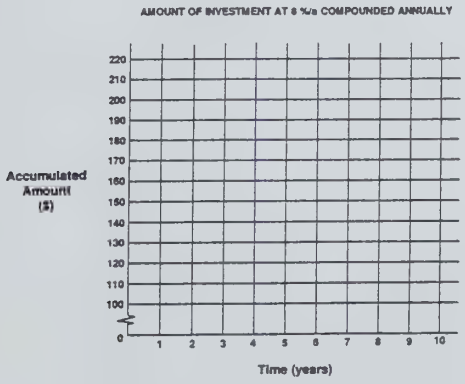
At 5 s, the height of water in the tank is:

A) 6 cm
B) 5.5 cm
C) 5 cm
D) 4.5 cm

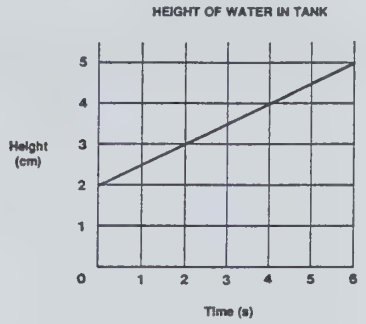
30. The table below shows the relation between the accumulated amount of an investment at 8%/a compounded annually and the number of years the amount has been invested.

Time (years)	0	2	4	6	8	10
Accumulated Amount ($)	$100	$117	$136	$159	$185	$216

Graph the relation on the grid below.



59. A tank is being filled with water. The graph below shows the height of water in the tank at different times.



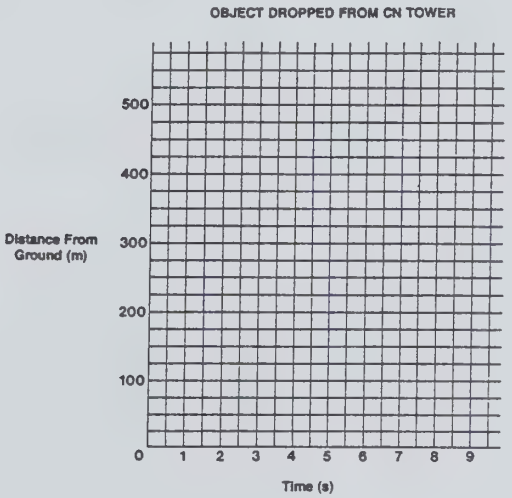
When the height of water in the tank is 3.5 cm, the amount of time that has passed is:

A) 2 s
B) 2.5 s
C) 3 s
D) 3.5 s

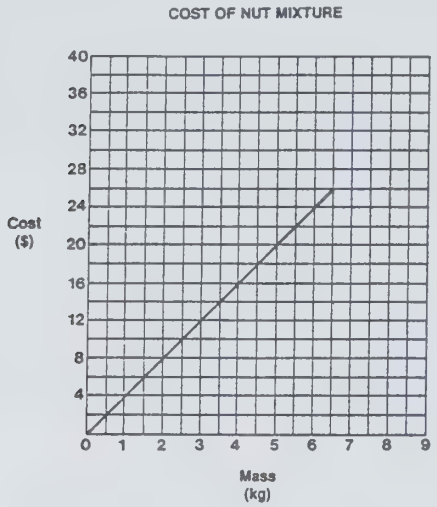
70. An object is dropped from the CN Tower. The table below shows the distance from the ground at different times.

Time (s)	1	3	5	7	9
Distance from the ground (m)	435	405	325	205	45

Graph the relation on the grid below.



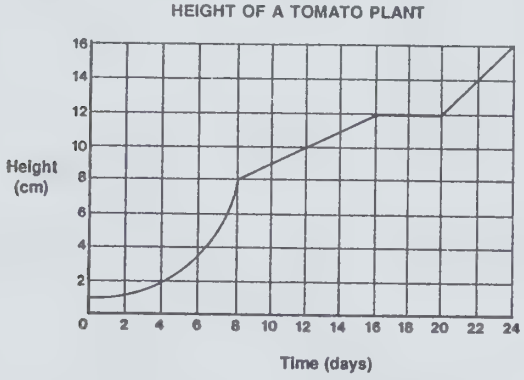
71. The graph below shows the cost of different masses of a nut mixture.



State the number of kilograms that can be bought for $34.

Answer: _____kg

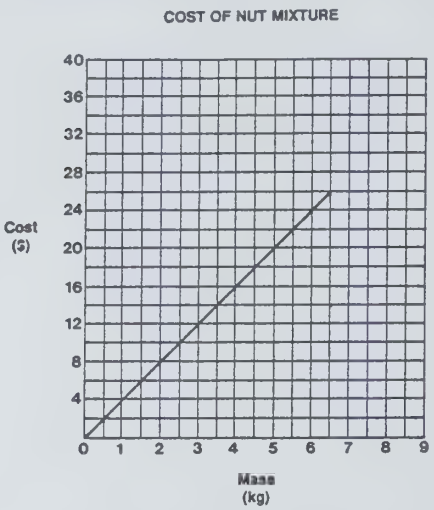
99. The graph below shows the height of a tomato plant as measured over 24 days for a science project.



During which days did the tomato plant not grow?

A) between the 2nd and the 8th day
B) between the 2nd and the 16th day
C) between the 20th and the 24th day
D) between the 16th and the 20th day

109. The graph below shows the cost of different masses of a nut mixture.



State the cost of 8.5 kg of this mixture.

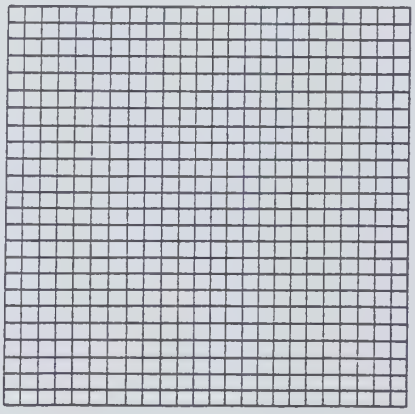
Answer: $ _____

112. Radioactive fluoride has a half-life of two hours. Suppose you start with 100 g of radioactive fluoride. The table gives the approximate amount of fluoride remaining at different times.

Time (h)	Mass of Flouride (g)
0	100
2	50
4	25
6	12.5

Draw a graph of this relation on the grid below.

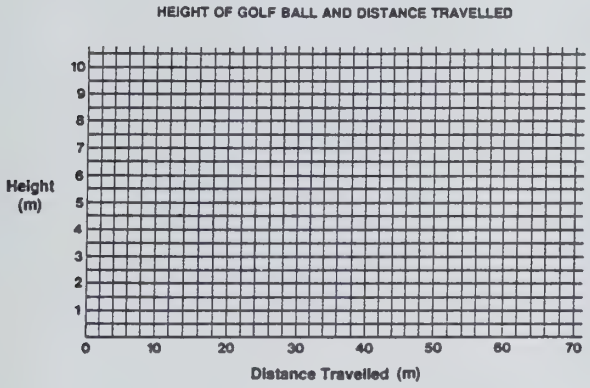
AMOUNT OF RADIOACTIVE FLUORIDE



149. The table below shows the height of a golf ball above the ground as compared to the distance it has travelled down a fairway.

Distance (m)	Height (m)
0	0
10	4.4
20	
30	9.4
40	10.0
50	8.5
60	5.1
65	3.2
70	0

(a) Draw a graph of the relation.



(b) Use your graph to estimate the height of the golf ball off the ground after it has travelled a distance of 20 m.

Answer: _____ m

150. The table below shows the relation between the population in a rabbit colony and the length of time in months.

Time (in months)	0	1	2	3	4	5
Number of rabbits	2	4	8	16	32	64

Draw a graph of the relation on the grid below.

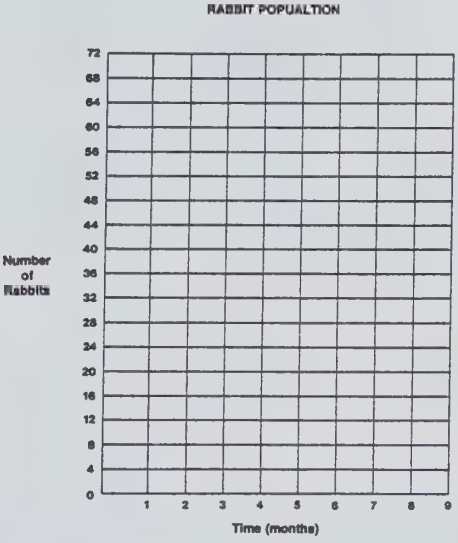


Table D-8
Algebra: Graphing

											Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Application	1-19	(D)	6	4	7	84		0	98	84	75	90	3
	1-30*							11	92	62	65	80	3
	2-59	(C)	3	7	67	23		0	98	67	75	90	2
	2-70*							19	96	34	55	70	2
	2-71*							16	96	57	60	80	2
	3-99	(D)	4	3	2	90		1	90	90	65	80	5
	3-109*							9	96	60	60	80	2
	3-112*							16	90	21	20	30	3
	4-149*							17	95	42	35	55	3
	4-150*							16	97	46	55	80	2

*Number of students for open-ended questions is 989, 962, 958, 951, 951, 942, and 944 (order as in table).

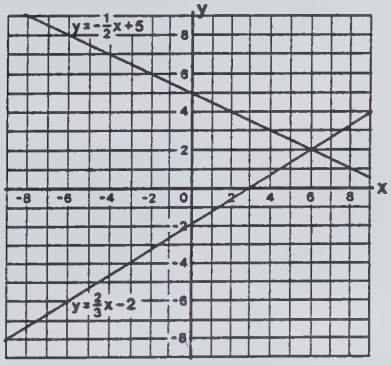
141. The point of intersection of two lines **p** and **q**:

A) is on both, lines **p** and **q**.
B) is not on either line, **p** or **q**.
C) is on line **p** but not on line **q**.
D) is on line **q** but not on line **p**.

21. When x = 1, the ordered pair (x,y) that makes the equation $y = -3x + 1$ true is:

A) (1, 0)
B) (1, –2)
C) (–2, 1)
D) (0, 1)

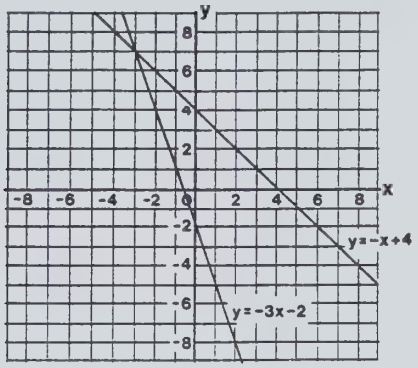
22. Two straight lines are shown on the graph below.



The point of intersection of the two lines $y = -\frac{1}{2}x + 5$ and $y = \frac{2}{3}x - 2$ is:

A) (3, 0)
B) (0, 5)
C) (6, 2)
D) (2, 6)

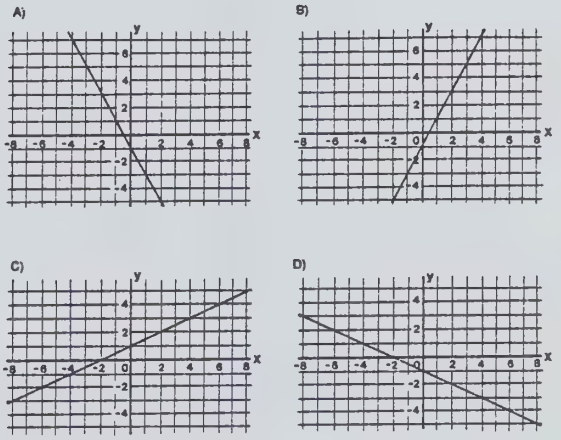
60. Examine the graph below:



The point of intersection of the two lines $y = -3x - 2$ and $y = -x + 4$ is:

A) (–3, 7)
B) (4, 0)
C) (0, 4)
D) (0, –2)

61. The graph of $y = -2x - 1$ is:

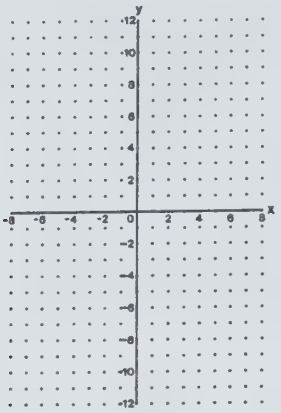


62. The solution for $x + y = 7$ and $x - y = 1$ is:

A) x = 1, y = 6
B) x = 3, y = 4
C) x = 4, y = 3
D) x = 8, y = –1

SHOW YOUR WORK

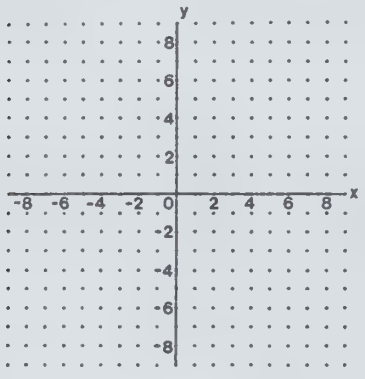
72. Draw the graph of $y = 2x - 5$.



101. Irene worked out the table of values below as the first step in graphing a straight line. One of the points is not correct because of a calculation error.

x	y
−1	−8
1	0
−3	−3
0	−4

Plot the 4 points on the diagram below to determine which point is incorrect.



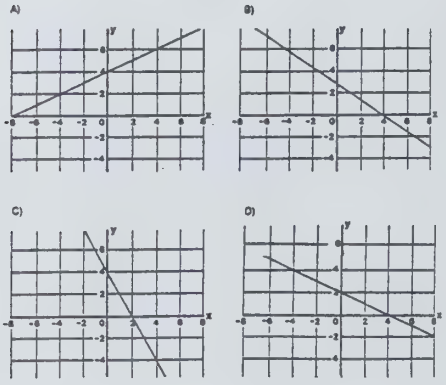
The incorrect point is:

A) (−1, −8)
B) (1, 0)
C) (−3, −3)
D) (0, −4)

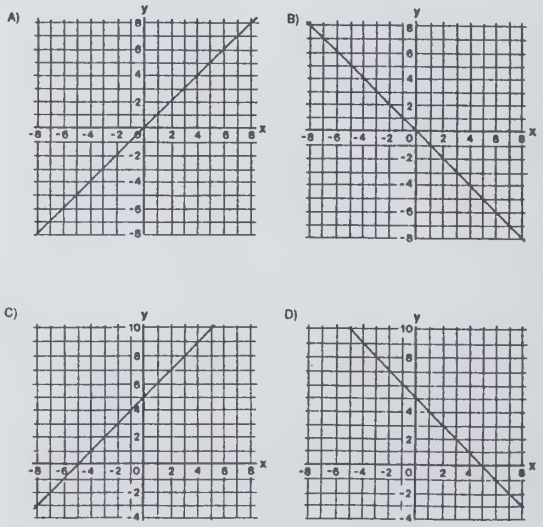
102. Alphonso worked out the table of values below as the first step in graphing a straight line for a given equation.

x	y
2	1
4	0
−2	3

The correct graph is:



140. The graph of $y = x + 5$ is:



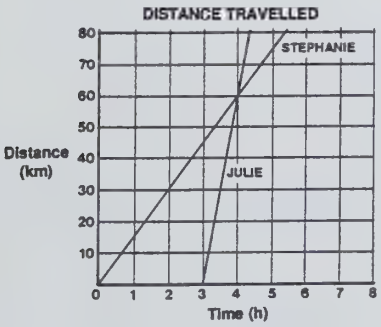
20. The chart below shows the number of copies (**n**) produced by a copying machine in t minutes.

Time in Minutes (t)	Number of copies (n)
1	100
2	200
3	300

The formula which relates the number of copies (**n**) to the time in minutes (**t**) is:

A) $n = t - 100$
B) $n = 100 + t$
C) $n = \frac{t}{100}$
D) $n = 100t$

31. Stephanie and Julie decided to travel the 90 km to their cottage one weekend. Stephanie rode a bike at an average speed of 15 km/h. Three hours after Stephanie left, Julie got in her car and drove along the same route at an average speed of 60 km/h. The graph below shows the distance each had travelled and the number of hours travelled.



When Julie catches up to Stephanie, how many hours has Stephanie been travelling?

Answer: _____

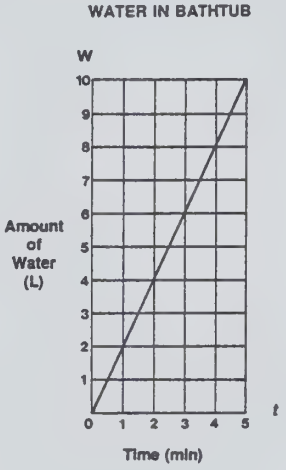
100. Read the following chart.

Number of Extra Toppings (n)	Cost of Pizza in dollars (c)
0	8.00
1	8.50
2	9.00
3	9.50

The formula that relates the cost (**c**) of pizza in dollars to the number (**n**) of extra toppings is:

A) $c = 8.50n$
B) $c = 8.00n + 0.50$
C) $c = 8.00 + 0.50n$
D) $c = n + 8.50$

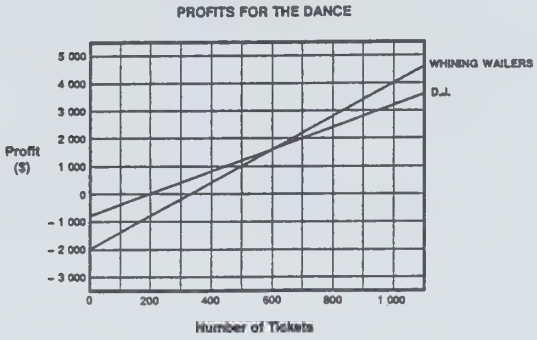
139. The graph below shows the number of litres of water in a bathtub compared to the length of time in minutes since the water was turned on.



A formula relating the number of litres (**w**) of water in the bathtub and the time in minutes (t) since the water was turned on is:

A) $w = t - 2$
B) $w = 2t$
C) $w = \frac{t}{2}$
D) $w = 2 + t$

142. The student council has two choices for the upcoming Valentine's Day Dance. They can bring in the Whining Wailers at a cost of $2 000 and charge $6 admission or they can hire a D.J. at a cost of $800 and charge $4 admission. Roberta drew the graph below to compare the profit to be made with the number of tickets sold.



The number of tickets that would give the same profit for both the Whining Wailers and the D.J. is:

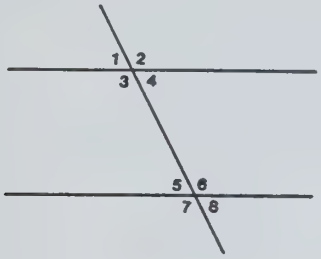
A) 2 000
B) 1 500
C) 800
D) 600

Table D-9
Algebra: Linear Equations

											Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Recognition/Recall	4-141	(A)	71	14	9	4		2	82	71	55	55	4
Comprehension	1-21	(B)	11	49	32	7		1	93	49	55	60	2
	1-22	(C)	3	7	77	12		1	87	77	75	90	3
	2-60	(A)	83	7	6	4		1	89	83	70	90	3
	2-61	(A)	26	24	23	25		2	94	26	55	70	1
	2-62	(C)	17	15	50	16		2	73	50	45	60	3
	2-72*							38	94	31	60	80	1
	3-101	(C)	10	26	54	10		1	93	54	60	75	2
	3-102	(D)	4	15	16	64		1	94	64	65	80	3
	4-140	(C)	15	11	43	28		3	94	43	70	85	1
Application	1-20	(D)	5	18	29	47		1	74	47	55	60	2
	1-31*							11	86	67	60	70	3
	3-100	(C)	12	15	55	17		1	74	55	50	50	4
	4-139	(B)	7	46	30	14		2	59	46	50	50	3
	4-142	(D)	7	32	7	53		2	81	53	50	75	3

*Number of students for question 2-72 is 957 and for question 1-31 is 988.

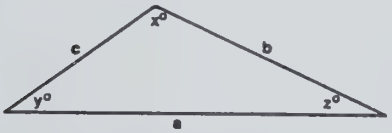
63. Examine the figure below:



One pair of corresponding angles in this diagram is:

A) $\angle 2$ and $\angle 8$
B) $\angle 4$ and $\angle 5$
C) $\angle 3$ and $\angle 5$
D) $\angle 1$ and $\angle 5$

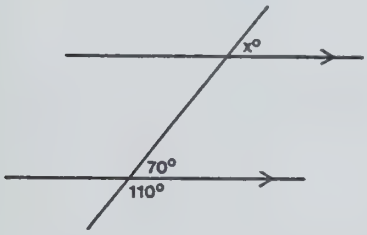
65. Examine the triangle below:



In the triangle above:

A) $x° + y° + z° = 180°$
B) $a + b + c = 180°$
C) $a = b + c$
D) $y° = x° + z°$

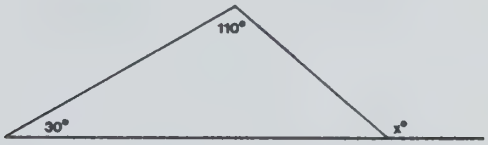
23. Examine the figure below:



The value of x is:

A) 20°
B) 40°
C) 70°
D) 110°

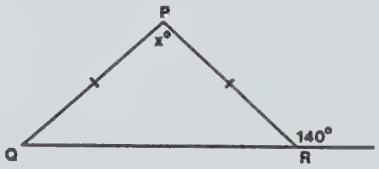
24. Examine the figure below.



The value of x is:

A) 30°
B) 40°
C) 110°
D) 140°

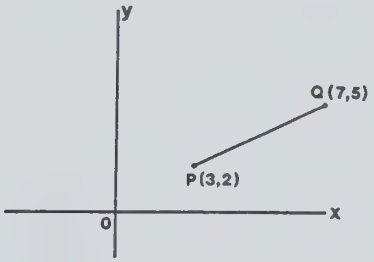
25. In the triangle below, PQ = PR.



The value of x is:

A) 40°
B) 70°
C) 80°
D) 140°

26. Examine the figure below:

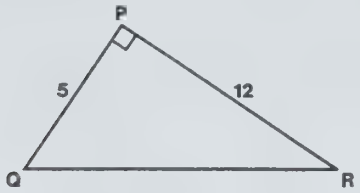


The length of PQ is:

A) 5
B) 7
C) 10
D) 25

Geometric Figures and Properties (cont'd)

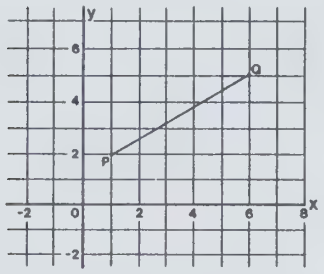
27. Examine the triangle below:



The length of QR is :

A) 7
B) 11
C) 13
D) 17

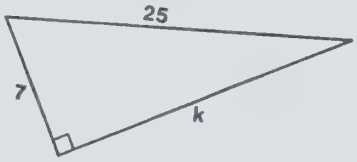
28. Examine the graph below:



The slope of PQ is:

A) $\frac{3}{5}$
B) $\frac{5}{3}$
C) $-\frac{3}{5}$
D) $-\frac{5}{3}$

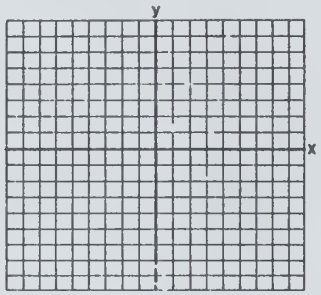
64. Examine the triangle below:



The value of **k** is :

A) 32
B) 26
C) 24
D) 18

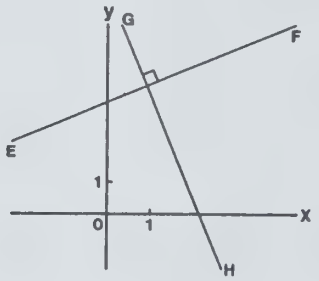
67. For this problem, you may use the grid if you wish.



The slope of the line joining P(–2, 4) and Q(3, 5) is:

A) –1
B) $-\frac{1}{5}$
C) 1
D) $\frac{1}{5}$

68. In the diagram below, GH is perpendicular to EF.

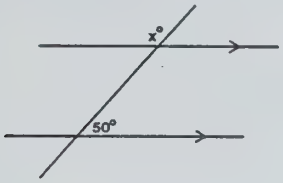


If the slope of EF is $\frac{2}{3}$, then the slope of GH is:

A) $-\frac{3}{2}$
B) $-\frac{2}{3}$
C) $\frac{2}{3}$
D) $\frac{3}{2}$

Geometric Figures and Properties (cont'd)

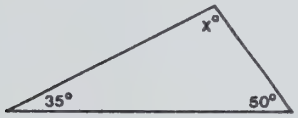
103. Examine the figure below:



The value of x is:

A) 40°
B) 50°
C) 100°
D) 130°

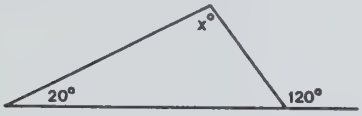
104. Examine the triangle below:



The value of x is:

A) 85°
B) 95°
C) 130°
D) 145°

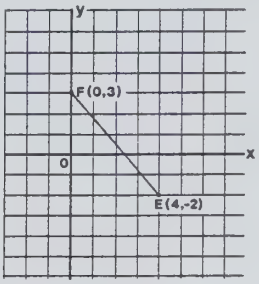
105. Examine the triangle below:



The value of x is:

A) 20°
B) 100°
C) 120°
D) 160°

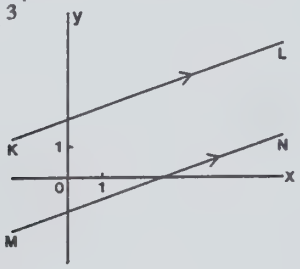
107. Examine the graph below:



The slope of EF is:

A) $-\frac{5}{4}$
B) $-\frac{4}{5}$
C) $\frac{4}{5}$
D) $\frac{5}{4}$

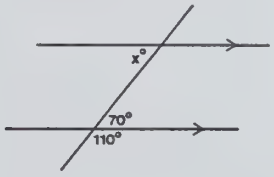
108. In the diagram below, MN is parallel to KL and the slope of KL is $\frac{1}{3}$.



The slope of MN is:

A) 3
B) $\frac{1}{3}$
C) $-\frac{1}{3}$
D) -3

143. Examine the figure below:

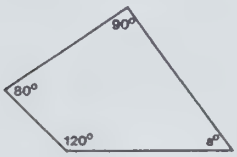


The value of x is:

A) 110°
B) 70°
C) 40°
D) 20°

Geometric Figures and Properties (cont'd)

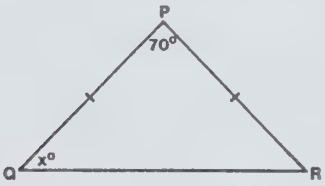
144. Examine the figure below:



The value of a is:

A) 50°
B) 70°
C) 90°
D) 130°

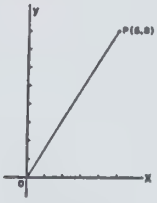
145. In the triangle below, PQ = PR.



The value of x is:

A) 35°
B) 55°
C) 70°
D) 110°

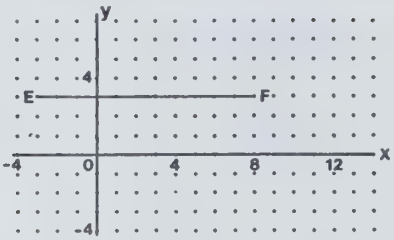
147. Examine the graph below:



The slope of OP is:

A) $-\frac{8}{5}$
B) $-\frac{5}{8}$
C) $\frac{5}{8}$
D) $\frac{8}{5}$

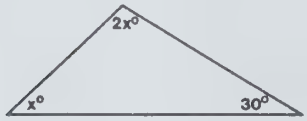
148. Examine the graph below:



The slope of EF is:

A) 0
B) $\frac{1}{8}$
C) 1
D) 8

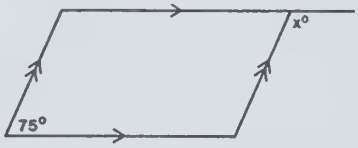
66. Examine the triangle below:



The value of x is:

A) 75°
B) 70°
C) 50°
D) 10°

106. Examine the figure below:

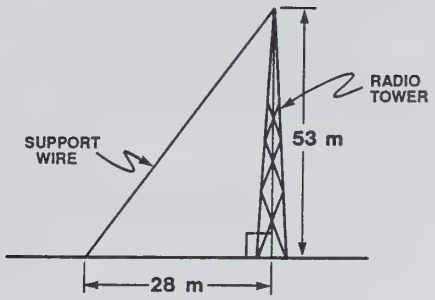


The value of x is:

A) 75°
B) 85°
C) 95°
D) 105°

Geometric Figures and Properties (cont'd)

146. The diagram below shows a radio tower.



The length of the support wire for the radio tower is approximately:

A) 25 m
B) 45 m
C) 60 m
D) 81 m

Table D-10
Geometry: Geometric Figures and Properties

											Panel Rating		
Level	*Item*	*Key*	*A*	*B*	*C*	*D*	*E*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
Recognition/Recall	2-63	(D)	14	27	17	40		2	44	40	55	70	2
	2-65	(A)	57	19	14	8		2	55	57	70	85	2
Comprehension	1-23	(C)	4	16	68	11		1	47	68	75	85	2
	1-24	(D)	10	37	9	44		1	50	44	65	75	2
	1-25	(A)	52	13	6	27		2	50	52	60	75	2
	1-26	(A)	35	37	20	6		3	61	35	45	45	2
	1-27	(C)	14	8	39	38		2	89	39	60	75	1
	1-28	(A)	50	32	10	5		3	75	50	50	70	2
	2-64	(C)	34	17	25	22		2	88	25	55	75	1
	2-67	(D)	15	21	30	32		2	70	32	55	70	1
	2-68	(A)	27	22	23	26		2	57	27	50	65	1
	3-103	(D)	12	37	10	41		1	46	41	60	75	2
	3-104	(B)	25	66	6	2		1	55	66	70	85	2
	3-105	(B)	12	56	16	15		2	50	56	60	80	2
	3-107	(A)	24	33	23	17		2	73	24	55	70	1
	3-108	(B)	10	57	24	7		3	66	57	65	80	2
	4-143	(B)	13	70	13	3		1	47	70	70	85	3
	4-144	(B)	20	57	11	11		1	46	57	60	80	2
	4-145	(B)	12	46	27	14		1	51	46	65	80	2
	4-147	(D)	6	7	58	28		1	73	28	60	75	1
	4-148	(A)	63	14	7	14		2	73	63	55	75	3
Application	2-66	(C)	11	19	54	14		2	53	54	60	75	3
	3-106	(D)	39	8	11	40		2	44	40	50	70	3
	4-146	(C)	8	10	41	39		2	92	41	60	90	2

Process Problems

SHOW YOUR WORK

33. Matchsticks are arranged as follows:

FIGURE 1 FIGURE 2 FIGURE 3

If the pattern is continued, how many matchsticks are used in making the 10th figure?

73. Tin Jee collects basketball cards. When they are stacked in piles of 2, there is 1 left over. When they are stacked in piles of 3, there is 1 left over. With piles of 5, there are none left over. If he has fewer than 50 basketball cards, how many cards does he have?

113. On the beach during the summer, Nina collected white and pink shells. On the first day, she found 2 white shells and 1 pink shell. On the next day, she found 4 white shells and 4 pink shells, and on the third day she found 6 white shells and 7 pink shells. If this pattern continued, on what day did she find 6 more pink shells than white shells?

153. A contest was held to guess the number of peanuts in a jar. Four wrong guesses were made: Sabrina, 163 peanuts; Pierre, 169; Yasmine, 178; and Carlos, 185. One of these guesses was wrong by 1, another by 6, another by 10, and another by 16. How many peanuts are there?

Table D-11
Process Problems

												Panel Rating		
Item	*Key*	*N*	*B*	*C*	*D*	*E*	*F*	*G*	*O*	*OTL*	*Cor*	*Acc*	*Des*	*Rtg*
1-33	B+C+D	985	33	2	13	8	5	26	12	32	48	60	80	2
2-73	B+C+D	955	11	1	7	1	3	31	45	18	19	10	35	3
3-113	B+C+D	944	34	0	2	12	9	15	26	28	37	20	60	3
4-153	B+C+D	937	20	1	7	3	5	27	36	19	28	10	50	3

B. Completes the solution correctly, using an appropriate strategy.

C. Gives the correct answer; starts an appropriate strategy, but does not complete it.

D. Gives the correct answer, but does not show reasoning/strategy.

E. Selects an appropriate strategy, but does not get correct answer due to a minor (e.g., computational) error.

F. Selects an appropriate strategy and shows understanding, but does not complete the solution or makes a major error in reasoning.

G. Attempts the question, but does not show understanding that would lead to a solution.

Table D-12
Percentage of Students Using Each Strategy for Process Problems

Item	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*S*
1-33	12	14	27	32	8	3	n/a	n/a	4
2-73	44	20	16	8	2	3	1	1	5
3-113	24	11	6	35	23	0	n/a	n/a	2
4-153	35	18	12	14	3	10	1	3	5

Strategies Represented by Each Letter

Item	*F*	*G*	*H*
1-33	Using a formula or equation	n/a	n/a
2-73	Estimating (guess and check)	Using a formula or equation	Accounting for all possibilities
3-113	Using a formula or equation	n/a	n/a
4-153	Estimating (guess and check)	Using a formula or equation	Working backwards

Note: A - Did not attempt the question.

B - Attempted the question, but does not show understanding that would lead to a solution.

C - Answer only, right or wrong; no work shown.

D - Searching for a pattern.

E - Constructing a table.

S - Some other strategy.

Table D-13
Scoring Criteria for Selected Open-Ended Questions

1-30	Step 1	11%	A. Does not attempt the question.
		79%	B. Plots all points within acceptable range.
		10%	C. Does not plot all points within acceptable range.
	Step 2	76%	A. Joins adjacent points with curve or line segments.
		11%	B. Draws a straight line of best fit.
		10%	C. Does not join points or draw line of best fit.
		4%	D. Draws a bar graph on histogram showing correct annual amounts.

Correct: *B* for Step 1 and *A* for Step 2.

1-32	24%	A. Does not attempt the question.
	46%	B. Correct answer - shows understanding of the features of an algebraic solution.
	1%	C. Correct answer - does not show understanding of the features of an algebraic solution or does not show work.
	18%	D. Incorrect answer or incomplete solution - shows understanding of the features of an algebraic solution.
	11%	E. Incorrect answer or incomplete solution - does not show understanding of the features of an algebraic solution or does not show work.

Correct: *B*

2-69	14%	A. Does not attempt the question.
	18%	B. Correct.
	51%	C. Correct except for rounding: 28.8 or 30.
	17%	D. Incorrect.

Correct: *B*

2-70	Step 1	19%	A. Does not attempt the question.
		69%	B. Plots all points within acceptable range.
		12%	C. Does not plot all points within an acceptable range.
	Step 2	46%	A. Joins adjacent points with curve.
		26%	B. Joins adjacent points with line segments.
		2%	C. Draws a straight line of best fit.
		26%	D. Does not join points or draw line of best fit.

Correct: *B* for Step 1 and *A* for Step 2.

Table D-13 (continued)
Scoring Criteria for Selected Open-Ended Questions

2-72		38%	A. Does not attempt the question.
		31%	B. Draws a correct graph.
		12%	C. Draws an incorrect graph or does not draw a line, but locates one point correctly or shows correct slope.
		3%	D. Locates 2 points correctly but does not draw the line.
		15%	E. Draws an incorrect graph which does not have the correct slope and does not have any point located correctly.

Correct: *B*

3-110	May 5	17%	A. Does not attempt the question.
		72%	B. Correct.
		11%	C. Incorrect.
	May 15	17%	A. Does not attempt the question.
		73%	B. Correct.
		10%	C. Incorrect.

Correct: *B* for May 5 and *B* for May 15.

				Yes	No
3-112	Step 1	Attempts the question.		84%	16%
		Labels axes (Time axis could be the vertical axis).		73%	27%
		Chooses appropriate scales (student might extend grid).		63%	37%
		Plots all points within acceptable range **or** draws a bar graph or histogram which shows entries in table correctly.		67%	33%
	Step 2	37%	A. Joins adjacent points with curve.		
		32%	B. Joins adjacent points with line segments.		
		7%	C. Draws a straight line of best fit.		
		25%	D. Does not join points or draw line of best fit.		

Correct: *Yes* for last three criteria in Step 1 and *A* for Step 2.

Table D-13 (continued)
Scoring Criteria for Selected Open-Ended Questions

4-149		17%	A. Does not attempt the question.
		42%	B. States answer within acceptable range from correctly drawn graph.
		11%	C. States answer within acceptable range, but does not draw graph or draws graph incorrectly.
		10%	D. Draws a correct graph, but does not read the height correctly from the graph.
		6%	E. Does not draw a correct graph, but reads height correctly from graph drawn.
		13%	F. Does not draw a correct graph and does not read height correctly from graph drawn.

Correct: *B*

4-150	Step 1	16%	A. Does not attempt the question.
		81%	B. Plots points within an acceptable range.
		3%	C. Does not plot points within an acceptable range.
	Step 2	55%	A. Joins adjacent points with curve.
		24%	B. Joins adjacent points with line segments.
		1%	C. Draws a straight line of best fit.
		20%	D. Does not join points or draw line of best fit.

Correct: *B* for Step 1 and *A* for Step 2.

4-151		25%	A. Does not attempt the question.
		47%	B. Correct answer - shows understanding of the features of an algebraic solution.
		0%	C. Correct answer - does not show understanding of the features of an algebraic solution or does not shown work.
		18%	D. Incorrect answer or incomplete solution - shows understanding of the features of an algebraic solution.
		10%	E. Incorrect answer or incomplete solution - does not show understanding of the features of an algebraic solution or does not shown work.

Correct: *B* or *C*

		Yes	No
4-152	Attempts the question	82%	18%
	Cash (blank)	52%	48%
	Cheque Amount	58%	42%
	Subtotal	57%	43%
	Less Cash	73%	27%
	Net Deposit	69%	31%

Correct: Completes all parts correctly.

The scoring criteria for the process problems was given in Table D-11. The remaining open-ended questions were simply scored correct or incorrect.

Part B: No-Calculator Questions

Find the No-Calculator Questions section on your answer sheet.

Read each of the following questions carefully.

Next to each question number on your answer sheet, fill in the bubble that contains the letter corresponding to your answer.

Use an HB pencil.

Make sure you begin with Question 51 on your answer sheet.

51. Calculate $\frac{3}{4} \times -\frac{2}{3}$.

A) -2
B) $-\frac{1}{2}$
C) $-\frac{5}{7}$
D) $\frac{1}{2}$

52. Calculate $-\frac{3}{4} \div \frac{1}{2}$.

A) $-\frac{3}{2}$
B) $-\frac{3}{8}$
C) $\frac{3}{8}$
D) $\frac{3}{2}$

53. Calculate $\frac{2}{3} - \frac{5}{4}$.

A) $-\frac{23}{12}$
B) $-\frac{7}{12}$
C) $-\frac{3}{12}$
D) $\frac{7}{12}$

54. 2.35 is the answer to:

A) $235 \div 10$
B) $2.35 \div 10$
C) $23.5 \div 10^2$
D) $235 \div 10^2$

55. $23.857\ 6 \times 10^3$ is:

A) 0.023 857 6
B) 23.857 600 0
C) 23 857.6
D) 238 576 000

56. 25.69 is the answer to:

A) $2\ 569 \times 100$
B) 256.9×100
C) 2.569×0.1
D) 256.9×0.1

57. A contractor charges \$9.85/m^2 to pave a parking lot. The cost of paving a 1 000 m^2 parking lot is:

A) \$985
B) \$9 850
C) \$98 500
D) \$985 000

58. During the first day of their vacation, Joachim's family drove a total of 7 h. The digits on their trip distance indicator were:

3	8	5	7

The most probable distance they drove is:
A) 3.9 km
B) 38.6 km
C) 385.7 km
D) 3 857 km

Table D-14
No-Calculator Questions

Item	*Key*	*A*	*B*	*C*	*D*	*O*	*Cor*	*Panel Rating*		
								Acc	*Des*	*Rtg*
51	(B)	10	68	14	8	0	68	60	70	3
52	(A)	63	21	6	9	1	63	55	65	3
53	(B)	6	51	22	20	1	51	55	65	3
54	(D)	23	11	13	53	1	53	55	90	2
55	(C)	14	14	57	14	0	57	60	90	2
56	(D)	23	10	29	37	1	37	55	90	1
57	(B)	5	60	13	21	1	60	65	90	2
58	(C)	5	11	55	29	1	55	60	90	3

Table D-15
Summary of Achievement Data by Topic

Topic	No. of Items	Average Percentage Correct			OTL	Panel Rating		
		Female	Male	Total		Acc	Des	Rtg
Numerical Methods	57	64.1	66.9	65.6	81.7	65	82	3
Applications of numbers	10	70.2	74.0	72.3	89.8	67	85	4
Powers and square roots	10	57.0	55.7	56.2	97.3	65	79	2
Applications of ratio, rate, and per cent	11	61.0	68.4	64.8	89.8	65	82	3
Statistics	10	65.9	67.3	66.6	65.2	62	77	4
Personal finance and banking	6	66.8	67.2	67.0	72.3	71	91	3
Borrowing and saving	10	65.1	68.7	67.2	71.0	66	83	3
Recognition/recall and comprehension	20	58.6	59.8	59.2	82.8	-	-	-
Application	37	67.1	70.7	69.0	81.0	-	-	-
Algebra	47	56.1	55.9	55.9	91.0	60	74	2
Polynomials, formulas, and equations	22	57.3	56.2	56.6	93.7	62	77	2
Graphing	10	55.4	57.2	56.4	94.8	57	74	3
Linear equations	15	54.8	54.6	54.5	84.5	58	70	3
Recognition/recall and comprehension	29	56.1	54.4	55.1	93.2	-	-	-
Application	18	56.1	58.2	57.2	87.4	-	-	-
Geometry	24	43.0	49.0	46.3	60.6	60	75	2
Process Problems	4	33.4	33.3	33.2	24.2	25	56	3
No-Calculator Questions	8	53.8	57.0	55.5	n/a	58	81	2

Table D-16
Teacher Responses for Opportunity to Learn

Percentage of Teachers

			Reasons for Not Teaching			
	Question Number	*Taught*	*Taught prior*	*Taught later*	*Not in curriculum*	*Other reasons*
Numerical Methods	1-1	89	9	1	1	1
	1-2	93	2	2	2	1
	1-3	99	1	0	0	0
	1-4	98	1	0	1	1
	1-5	64	16	12	4	5
	1-6	90	7	2	1	1
	1-7	84	3	12	0	1
	1-8	55	2	25	8	10
	1-9	58	6	28	1	7
	1-10	69	1	22	4	4
	1-11	69	0	23	3	5
	1-12	75	2	20	1	2
	1-13	82	1	17	1	0
	1-29	96	1	1	1	0
	2-41	92	3	2	1	2
	2-42	93	2	1	2	2
	2-43	97	2	1	0	0
	2-44	92	2	2	2	2
	2-45	78	3	16	1	2
	2-46	59	7	16	3	14
	2-47	95	1	4	0	1
	2-48	89	1	9	1	1
	2-49	58	5	25	4	7
	2-50	69	1	22	1	7
	2-51	80	2	18	0	0
	2-52	51	1	26	7	15
	2-53	73	1	22	1	3
	2-69	82	9	2	3	3
	3-81	78	5	15	0	2
	3-82	96	4	0	0	1
	3-83	92	0	1	6	1
	3-84	99	0	0	1	0
	3-85	82	3	11	0	4
	3-86	95	2	4	0	0
	3-87	52	3	26	7	12
	3-88	59	7	25	3	6
	3-89	64	3	18	4	12

Table D-16 (cont'd)
Teacher Responses for Opportunity to Learn

Percentage of Teachers

			Reasons for Not Teaching			
	Question Number	*Taught*	*Taught prior*	*Taught later*	*Not in curriculum*	*Other reasons*
Numerical Methods (continued)	3-90	89	2	7	1	1
	3-91	69	1	20	3	8
	3-92	68	0	21	7	4
	3-93	79	1	18	1	1
	3-110	71	1	21	1	6
	3-111	84	3	11	0	1
	4-121	90	8	0	1	1
	4-122	71	5	10	4	10
	4-123	89	1	4	2	4
	4-124	99	0	0	1	0
	4-125	99	1	0	1	0
	4-126	92	4	2	1	1
	4-127	83	3	12	1	1
	4-128	96	2	2	1	0
	4-129	55	2	25	8	9
	4-130	60	6	27	2	4
	4-131	68	1	22	2	7
	4-132	67	0	21	7	5
	4-133	59	0	24	7	11
	4-152	59	4	26	3	8

Table D-16 (cont'd)
Teacher Responses for Opportunity to Learn

Percentage of Teachers

			Reasons for Not Teaching			
	Question Number	*Taught*	*Taught prior*	*Taught later*	*Not in curriculum*	*Other reasons*
Algebra	1-14	76	1	7	8	8
	1-15	85	10	3	0	2
	1-16	98	0	1	1	0
	1-17	88	2	3	3	4
	1-18	77	4	6	7	6
	1-19	96	1	2	1	0
	1-20	73	1	7	12	7
	1-21	93	0	5	1	1
	1-22	87	0	8	4	1
	1-30	92	0	4	2	1
	1-31	86	1	4	5	5
	1-32	98	1	1	1	0
	2-54	98	1	1	1	0
	2-55	84	8	4	2	2
	2-56	78	10	4	4	4
	2-57	95	1	1	0	4
	2-58	98	0	1	1	0
	2-59	96	2	2	0	0
	2-60	89	0	8	2	2
	2-61	94	0	5	1	0
	2-62	73	0	11	10	6
	2-70	96	0	2	1	1
	2-71	96	0	2	1	1
	2-72	94	0	5	1	0
	3-94	74	1	6	9	9
	3-95	98	0	1	1	0
	3-96	98	0	1	1	0
	3-97	98	0	1	1	0
	3-98	98	0	1	1	1
	3-99	87	3	5	3	1
	3-100	74	0	6	10	10
	3-101	93	0	4	1	2
	3-102	93	1	4	1	1
	3-109	95	1	1	2	1
	3-112	90	0	3	3	4

Table D-16 (cont'd)
Teacher Responses for Opportunity to Learn

Percentage of Teachers

	Question Number	*Taught*	*Reasons for Not Teaching*			
			Taught prior	*Taught later*	*Not in curriculum*	*Other reasons*
Algebra (continued)	4-134	98	1	1	1	0
	4-135	98	1	1	1	0
	4-136	97	1	1	1	0
	4-137	98	0	1	1	0
	4-138	93	1	3	1	3
	4-139	58	1	9	14	18
	4-140	94	0	5	1	1
	4-141	82	1	9	4	5
	4-142	81	0	9	6	4
	4-149	95	0	4	1	0
	4-150	97	0	2	1	0
	4-151	97	1	1	1	1

Table D-16 (cont'd)
Teacher Responses for Opportunity to Learn

Percentage of Teachers

			Reasons for Not Teaching			
	Question Number	*Taught*	*Taught prior*	*Taught later*	*Not in curriculum*	*Other reasons*
Geometry	1-23	44	3	41	6	7
	1-24	45	5	40	4	5
	1-25	45	5	40	5	5
	1-26	61	0	27	5	7
	1-27	89	0	8	1	1
	1-28	74	1	19	2	5
	2-63	40	4	40	6	10
	2-64	88	0	10	0	2
	2-65	45	9	36	2	7
	2-66	46	7	37	2	7
	2-67	69	1	22	2	5
	2-68	57	0	27	4	11
	3-103	41	5	39	6	8
	3-104	47	7	38	2	5
	3-105	44	6	38	5	6
	3-106	40	4	40	10	7
	3-107	73	0	20	1	6
	3-108	66	0	25	2	7
	4-143	42	4	41	6	6
	4-144	40	6	43	6	6
	4-145	45	6	39	5	5
	4-146	92	0	5	1	2
	4-147	73	0	21	1	5
	4-148	72	1	20	1	6
Process Problems	1-33	28	4	7	36	25
	2-73	18	0	12	32	39
	3-113	27	1	10	34	27
	4-153	18	1	9	35	37

Appendix E: Confidence Intervals for Achievement Results

This review used a matrix sampling of students and test questions. Questions were divided into four assessment booklets, and each student participating in the review responded to only one booklet. Since each student did not answer all questions, there is a degree of uncertainty associated with the achievement results reported in Appendix D. The estimates from matrix samples are generally good for scores that sum across the matrix samples – that is, that include questions from each booklet and therefore include information about all students. The statistical accuracy of an estimated response rate for a single item is, on the other hand, relatively low, since the item is answered by only one-quarter of the students.

The magnitude of the uncertainty for each curriculum area and for individual items is given in Table E-1 in the form of the 95 per cent confidence-band widths. For example, the band width for *Numerical Methods* is ±0.5 per cent, and the average percentage correct as reported in Table D-15 is 65.6. The confidence interval for this topic is 65.6 per cent plus or minus 0.5 per cent, or 65.1 to 66.1 per cent. The average percentage correct would fall within this range 95 times out of 100 if the review were repeated with similar sampling procedures.

The band width for an individual item depends on the percentage correct. For example, an item answered correctly by 53 per cent of students has a band width of ±3.2 per cent. The confidence interval for the item is 53 per cent plus or minus 3.2 per cent.

Since all students participating in the review answered all the No-Calculator Questions, there is no sampling error associated with the results for these questions.

The confidence-band widths for each curriculum area for the averages for female and male students are given in Table E-2. Results for individual questions were not reported by gender.

Table E-1
Confidence-Band Widths for Achievement Topics and Individual Items

Confidence-band Width (±%)	*Topic*
0.5	*Numerical Methods*
0.8	Applications of numbers
1.0	Powers and square roots
0.9	Applications of ratio, rate, and per cent
0.9	Statistics
1.1	Personal finance and banking
0.9	Borrowing and saving
0.7	Recognition/recall and comprehension
0.6	Application
0.6	*Algebra*
0.8	Polynomials, formulas, and equations
1.0	Graphing
0.9	Linear equations
0.7	Recognition/recall and comprehension
0.8	Application
0.8	*Geometry*
1.1	*Process Problems*

Confidence-band Width (±%)	*Individual Item*
1.9	Individual item with 10% correct response
2.5	Individual item with 20% correct response
2.9	Individual item with 30% correct response
3.1	Individual item with 40% correct response
3.2	Individual item with 50% correct response
3.1	Individual item with 60% correct response
2.9	Individual item with 70% correct response
2.5	Individual item with 80% correct response
1.9	Individual item with 90% correct response

Table E-2
Confidence-Band Widths for Achievement Topics by Gender

Confidence-band Width (±%)		*Topic*
Females	*Males*	
0.8	0.7	*Numerical Methods*
1.3	1.1	Applications of numbers
1.4	1.3	Powers and square roots
1.4	1.2	Applications of ratio, rate, and per cent
1.4	1.3	Statistics
1.7	1.5	Personal finance and banking
1.4	1.3	Borrowing and saving
1.1	0.9	Recognition/recall and comprehension
0.9	0.8	Application
0.9	0.9	*Algebra*
1.2	1.1	Polynomials, formulas, and equations
1.5	1.4	Graphing
1.3	1.2	Linear equations
1.0	1.0	Recognition/recall and comprehension
1.3	1.1	Application
1.1	1.1	*Geometry*
1.6	1.5	*Process Problems*

Appendix F: Analysis of Planning Documents

Type of Document

1. Number of school-level documents: 98

2. Number of board-level documents: 14

The numbers in this appendix specify the percentage of documents that met a specified criteria. One set of percentages is given for the 98 school-level documents that were submitted and one set of percentages is given for the 14 board-level documents.

	School		Board	
Course Guideline	**Yes %**	**No**	**Yes %**	**No**
3. Was the appropriate guideline identified (*Curriculum Guideline Mathematics Intermediate and Senior Divisions, 1985, Part 2: Grades 9 and 10, General Level*)?	81	19	79	21
4. Did the document include a general description of the course?	38	62	64	36
5. Was the level of difficulty at which the course is offered indicated **or** the common course code identified?	99	1	100	0
6. Was a credit value indicated?	78	22	79	21

Suggested Minimum Number of Hours in Guideline		Objectives Listed			
		School		Board	
Content Area		**Yes** %	**No**	**Yes** %	**No**
7. Were the following content objectives listed and did they state a time requirement consistent with the guidelines indicated in the brochure?	*Suggested Hours*				
Numerical Methods:					
• Number applications	(5)	98	2	93	7
• Powers and square roots	(7)	98	2	93	7
• Application of ratio, rate, and per cent	(6)	96	4	93	7
• Statistics	(9)	95	5	93	7
• Personal financing and banking	(6)	94	6	93	7
• Borrowing and saving	(7)	96	4	93	7
• Applied trigonometry	(optional)	36	64	33	67
Algebra:					
• Polynomials, formulas, and equations	(12)	98	2	93	7
• Graphing	(6)	97	3	93	7
• Linear equations	(8)	97	3	93	7
Geometry:					
• Geometric figures and properties	(14)	95	5	93	7
Core extension or options	(30)	52	48	58	42
Minimum total time requirement	110				

Content Area		Minimum Time Requirement Met			
		School		Board	
		Yes %	No	Yes %	No
7. Were the following content objectives listed and did they state a time requirement consistent with the guidelines indicated in the brochure?	*Suggested Hours*				
Numerical Applications:					
• Number applications	(5)	90	10	92	8
• Powers and square roots	(7)	85	15	92	8
• Application of ratio, rate, and per cent	(6)	84	16	92	8
• Statistics	(9)	62	38	83	17
• Personal financing and banking	(6)	60	40	100	0
• Borrowing and saving	(7)	72	28	100	0
• Applied trigonometry	(optional)	18	82	50	50
Algebra:					
• Polynomials, formulas and equations	(12)	76	24	69	31
• Graphing	(6)	79	21	62	38
• Linear equations	(8)	76	24	77	23
Geometry:					
• Geometric figures and properties	(14)	64	36	83	17
Minimum total time requirement	110				
8. Did the document address the following process components?					
• Experiential approach		14	86	31	69
• Proof		13	87	15	85
• Problem solving		24	76	31	69
9. Was there an indication of a scope and sequence **or** program delivery chart?		97	3	93	7

Course Objectives	School Yes %	School No	Board Yes %	Board No
10. Was a rationale/statement of philosophy outlined?	50	50	57	43
11. Were general course aims included?	72	28	85	15
12. Were objectives included for each content area?	75	25	93	7
13. Were the following types of objectives included?				
(a) Attitudes	43	57	77	23
(b) Skills	71	29	93	7
(c) Knowledge	78	22	93	7
14. Were the objectives mainly stated in terms of students' learning outcomes for the following?				
(a) Attitudes	17	83	21	79
(b) Skills	42	58	79	21
(c) Knowledge	38	62	79	21

Teaching Methods	School Yes %	School No	Board Yes %	Board No
15. Did the documents include a multi-resource approach to mathematics?	22	78	64	36
16. Were possible instructional methods/ teaching strategies described?	33	67	64	6
17. Were sample activities/lesson plans/ tasks/problems provided?	11	89	50	50
18. Was the specific use of calculators indicated?	24	76	36	64
19. Was the specific use of computers indicated?	6	94	21	79
20. Did the teaching strategies include the use of mathematics equipment?	16	84	43	57

Evaluation Practices	School % Yes	School % No	Board % Yes	Board % No
21. Were theoretical or background statements about assessment/evaluation included?	13	87	42	58
22. Were evaluation practices described?	21	79	23	77
23. Were the following evaluation procedures included?				
• Formative evaluation				
— records of previous achievement	1	99	7	93
— topic or unit pretests (ranging from informal oral questioning to written diagnostic tests)	9	91	21	79
— systematic observations of attitudes and performance, including oral and written presentations of solutions to problems	45	55	71	29
— informal questioning related to specific objectives	5	95	0	100
— teacher-student discussions or interviews, which could include informal or formal diagnostic strategies to probe levels of understanding	2	98	0	100
— self-evaluation by students	0	100	7	93
— peer evaluation by students	1	99	0	100
• Summative evaluation				
— topic or unit post-tests	84	16	86	14
— formal examinations at specific intervals	80	20	64	36
— standardized tests related to course objectives	1	99	0	100
— projects or essays	43	57	64	36
24. Was the relative emphasis/weight of evaluation components for student marks/grades outlined?	72	28	62	38
25. Was information on reporting to parents outlined?	1	99	8	92

Resources	School Yes %	School No	Board Yes %	Board No
26. Was a textbook or other learning materials indicated?	91	9	79	21
27. Was a list of reference books or other professional materials for use by teachers provided?	44	56	50	50
28. Was the use of concrete manipulative aids outlined?	9	91	21	79

Appendix G: Committee Members

This appendix lists members of the following committees: item development, face validity check, marking of screening materials, marking reliability, planning documents analysis, and interpretation panel. All committees had both English-speaking and French-speaking members and were divided into English and French subcommittees to deal with issues specific to each language. General issues that applied to the reviews in both languages were discussed by all members of a given committee.

Ministry of Education personnel were responsible for directing the various activities of the committees and for providing in-service for the board contacts and support for schools and boards involved in the review.

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Dana D'Amore	Learning Assessment Branch
Gérald Hurtubise	Région de l'est de l'Ontario
Michael Kozlow, Ph.D.	Learning Assessment Branch
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Trevor Thompson	Hamilton Board of Education

Planning Documents Analysis Committee

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Melodie Baldin	Niagara South Board of Education
James Braham	Haldimand Board of Education
Lorraine Palmer-Smith	Leeds and Grenville County Board of Education

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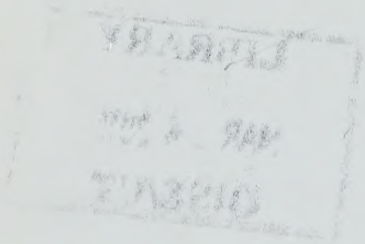

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